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The Purbeck Beds of the Weald (England)

BY

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and

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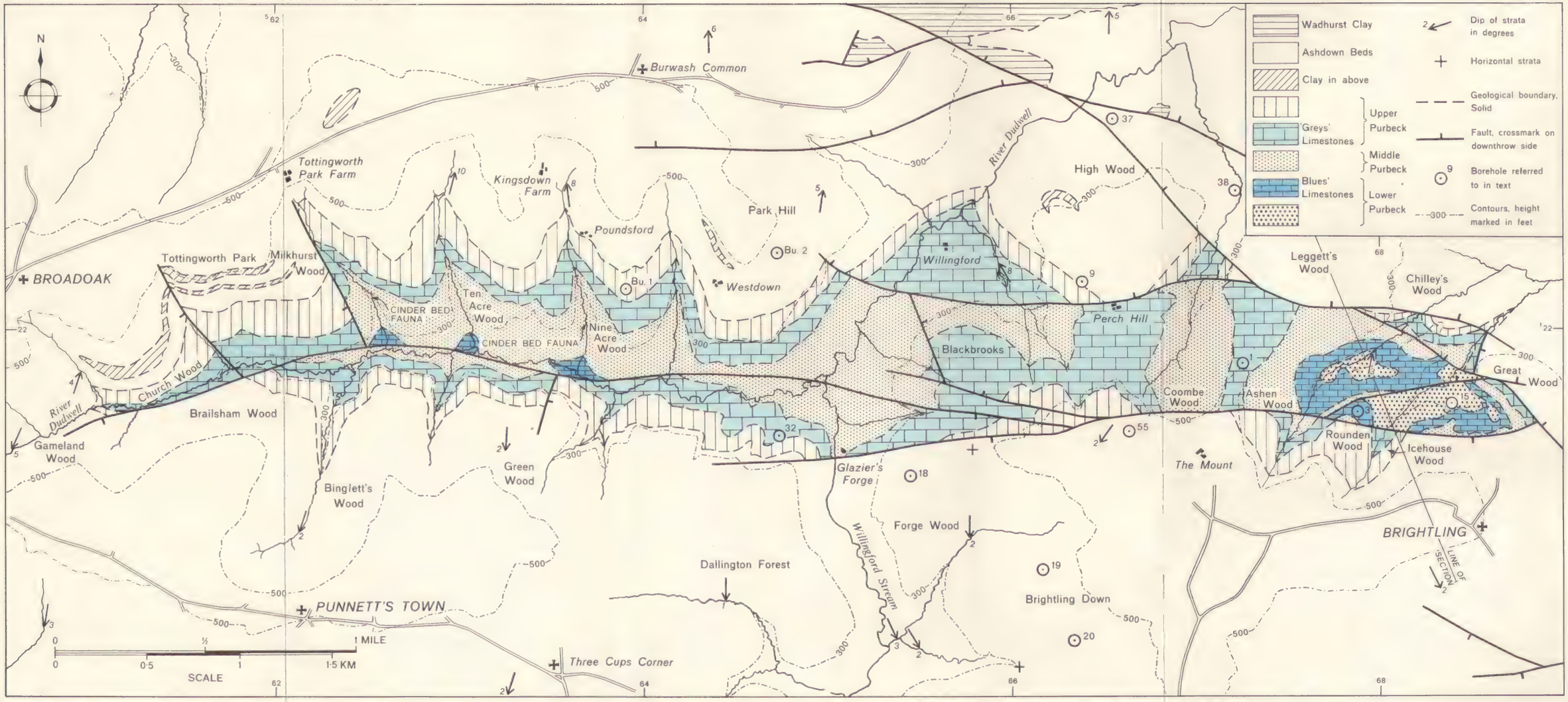


GEOLOGICAL MAP OF THE BROADOAK–BRIGHTLING INLIER OF THE PURBECK BEDS

THE PURBECK BEDS OF THE WEALD (ENGLAND)

Summary. The Purbeck Beds of the Weald are described from surface outcrops and numerous boreholes. Part I deals with the structure, general stratigraphy and lithology of the beds, Part II with the sequence of ostracod faunas, first of the Purbeck as a whole and second in the more important boreholes and surface exposures. Correlation between the Purbeck sequence in the Weald and in Dorset is attempted. Finally, the ostracod species found in the Purbeck Beds and a few from the Wealden are described and illustrated, including two new genera (*Eoparacypris* and *Pseudocypridopsis*) and forty-eight new species and subspecies all described by F. W. Anderson.

Part I

STRATIGRAPHY AND STRUCTURE

BY

R. A. B. BAZLEY, B.SC., PH.D.

INTRODUCTION

THE PURBECK BEDS in south-east England consist mainly of medium grey shaly mudstones and limestones. The more arenaceous Portland Beds lie below and the Ashdown Beds above. In Sussex they crop out in three major inliers (Fig. 2) between Heathfield and Battle. Most surface exposures are found in the bottoms of valleys that have been deeply dissected by streams, particularly the tributaries and the main courses of the Rivers Dudwell and Line. The country is very heavily wooded and this, coupled with the deep and usually overgrown ravines, makes a detailed examination of the rock outcrops difficult. Presumably this is why few geologists, with the notable exception of Howitt (1964), have studied all the many small exposures. In the Sussex inliers the formation is about 480 ft thick. In the Broadoak–Brightling Inlier it is exposed in the core of a major anticline, trending generally east to west, which is *en-échelon* with the major Crowborough anticline several miles to the north. The Purbeck Beds within the Hollingrove–Netherfield Inlier are in an anticlinal structure which is intimately associated with a major south-east trending fault zone (p. 17). Similarly the rocks of the Archer Wood Inlier are at surface level mainly because of faulting. The lowest beds of the Purbeck are not exposed at the surface anywhere in Sussex, the oldest rocks seen being just over 60 ft above the base. The sandy strata at the top of the Portland Beds beneath the gypsiferous lower horizons of the Purbeck Beds are easily located in boreholes. The top of the Purbeck Beds is taken at the junction of a thick bed of clay with silts and sands of the Ashdown Beds. A representative collection of the macrofauna from these inliers is in the Institute collections. Unfortunately not all the material from the surface exposures is of good quality and the precise determination of the remainder would have taken too long for it to be included in this paper. Future detailed work on the macrofaunas and their ecology might well produce interesting results, particularly for comparison with the findings of the micropalaeontology.

Regarding the history of research on this formation Conybeare and Phillips (1822) were the first to suggest that "this argillo-calcareous formation will probably be found, on an attentive examination of all its beds, especially the lowest, to coincide with that of the Purbeck . . . .". Mantell (1833) caused early confusion in the nomenclature by equating the Purbeck limestones of the Battle

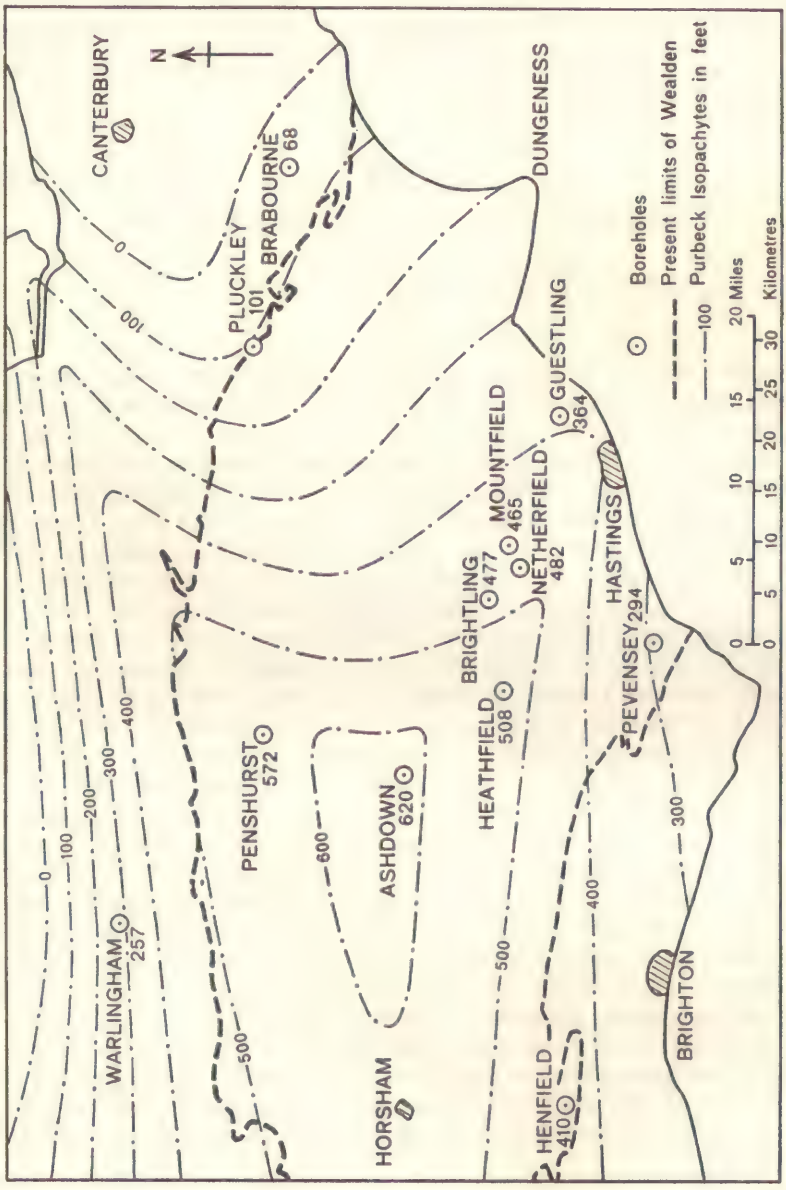


FIG. 1. *Sketch-map of the Weald showing the positions of boreholes and isopachytes of the Purbeck Beds*

area with a bed of shelly limestone at the base of the Wadhurst Clay and calling these the Ashburnham Beds. Topley (1875) admirably reviewed the previous literature on the area and recognizing the reasons for the confusion over the term Ashburnham Beds dropped this name from the classification. He was the first to describe the three Purbeck Inliers of Sussex in detail, but relied to a great extent on notes collected from the old stone-miners who had been employed in the workings for Purbeck limestone. For this reason his descriptions are couched in phrases coined by these workers. The first boreholes put down through the Purbeck in East Sussex were by the Sub-Wealden Exploration Company in 1872–6. The main Sub-Wealden borehole [7194 1930][1] (W1 on Plate IV; Survey Number 320/31), drilled in search of coal, showed the presence of workable gypsum deposits in the Lower Purbeck. Topley (op. cit.) described the sequence encountered.

Several of the later authors on the geology of this district drew heavily on Topley for their details; for example, Woodward (1895), White (1928) and Arkell (1933). Milner (1922) examined the inliers and suggested some modifications to the previously accepted structure but apart from this, until 1964, very few details were published that added much to the knowledge of the stratigraphy or structure.

Boreholes drilled in exploration for coal, oil and gas within Sussex and Kent during the past 60 years have been a constant source of information about the variations in thickness of the Purbeck Beds (Fig. 1). The most recent report on coal exploration boreholes was by Lamplugh, Kitchin and Pringle (1923), and the latest on oil and gas exploration was by Falcon and Kent (1960). Both these reports give reference to earlier publications.

The gypsum and anhydrite deposits that are found over a wide area at the base of the formation were discussed by Sherlock (1921), Sherlock and Hollingworth (1938) and Groves (1958). The latter included details of the methods of extracting the ore as did Gibson (1958, 1963). Economically the present importance of the Purbeck Beds lies in these deposits. In 1968 the Mountfield Mine, ¾ mile north-east of Netherfield [7206 1940], was producing some 200 000 tons per annum all of which is extracted from the lowest (No. 4) seam; production in the upper beds having now ceased. The bulk of the former production has since 1963 been transferred to the Brightling Mine [6770 2187] now producing 450 000 tons per annum, which is made up of 180 000 tons per annum from the No. 1 seam, approximately 6 ft thick, and 270 000 tons from the No. 4 seam. The system of working is identical at both mines, pillar and stall with inter-seam drifts. Since 1965, following an emission of methane gas in No. 1 seam, Brightling Mine has been declared a 'safety light' mine (Gibson, personal communication).

In 1960, during the primary six-inch to the mile survey of the Tenterden (304) Sheet by the Geological Survey, small parts of the Broadoak–Brightling Inlier and the Hollingrove–Netherfield Inlier were mapped by E. A. Edmonds. This survey indicated the possibility of dividing the Purbeck Beds on the basis of limestone groups but insufficient area was covered to be certain whether these horizons were continuous. In 1965 the primary six-inches to a mile geological

[1]National Grid References are given in this form throughout the paper. All lie within the major grid square TQ.

survey of the Tunbridge Wells (303) Sheet was completed. This included part of the Broadoak–Brightling Inlier and in conjunction with the start of the primary survey of the Hastings (320) Sheet in the same year all the inliers of Purbeck Beds in Sussex were examined by one of us (R.A.B.). This research proved that the limestone horizons noted by Edmonds in 1960 were continuous over the extent of the inliers so the small areas previously mapped were re-surveyed (by R.A.B.) to locate the precise boundaries of these limestone groups, which proved invaluable in determining the geological structure of the district. The two main limestone groups (Plates I and IV) have been described previously by Topley (1875) and Howitt (1964) as the 'Blues' and the 'Greys'. These stone-miners' terms are so well entrenched in the literature that to avoid confusion with reference to previous works they have been retained and here the groups are called the Blues Limestones and the Greys Limestones. The former is the upper part of the Lower Purbeck and the latter the lower part of the Upper Purbeck.

To date the most complete work on the Purbeck Beds of Sussex has been by Howitt (1964). This research gave a detailed interpretation of the structures present within and in the immediate vicinity of the three inliers as well as much new information on the sediments. The structural analysis was obviously considerably aided by the wealth of information gained from the extensive exploratory drilling programme that British Gypsum Limited, a subsidiary of British Plaster Board Limited, have undertaken. The sites of most of these boreholes, drilled to prove the gypsum deposits, are given by Howitt (op. cit., pl. 4). In the present paper only the sites of boreholes which are specifically mentioned in the text are shown on Plates I and IV although the logs of all boreholes were studied. For clarity on the plates the numbers used are abbreviations of those given by British Gypsum Limited and not the Geological Survey numbers. These are cross-referenced in the text.

The surface geological mapping of the area shown in Fig. 2 was undertaken by R. A. Bazley except in the vicinity of Burwash, which was surveyed by E. A. Edmonds in 1960 on County Sheets Sussex [East] 43 N.W. and Sussex [East] 30 S.W. The small area on National Grid Sheet TQ 71 N.E. (S) to the east of Battle was taken from the maps of R. D. Lake completed in 1967 as part of the primary six-inch survey of the Hastings (320) Sheet.

Detailed research on the microfauna, particularly the ostracod faunas and systematics, was undertaken by F. W. Anderson. The zonation of the Purbeck Beds proved in other areas (Anderson 1939, 1940, 1941, 1958, 1962) by the ostracod assemblages is extended to and completed in this district. The Lower, Middle and Upper Purbeck have been recognized from the ostracod faunas and these divisions were found to coincide closely with the lithological divisions (Fig. 4). Evidence from boreholes outside the immediate area of the Sussex inliers, i.e. at Warlingham and Winchester, is also given to indicate the change in lithology and fauna between Sussex and the Purbeck-type areas in Dorset and Hampshire. Sedimentary conditions prevailing at the time are discussed.

In Part II the ostracod species found in the Purbeck Beds are described including some not before recorded from the Weald. A few Wealden forms described are included either because they occur also in the Upper Purbeck or belong to genera known from the Purbeck Beds.

The authors thank E. A. Edmonds for his co-operation in the initial stages of this project. Mr. W. S. Gibson (British Gypsum Limited) kindly gave details of recent production figures and methods of working in the Sussex mines. We are indebted to British Gypsum Limited for giving ready access to their borehole records and land.

Structure

Situated near the centre of the Wealden anticlinorium the dominant structural elements in this area are major west-north-west trending strike faults. Between Burwash Common and Punnett's Town (Fig. 2) there is the westerly trending axis of an anticline, strata to the north of the Dudwell Fault generally dipping at about 8° to the north and on the other side at about 2° to the south. This anticlinal structure has been traced for some distance westwards from Broadoak but eventually dies out. This may be linked with the major westerly trending anticline through Crowborough about 5 miles to the north which fades out to the east, these two major structures being *en-échelon*. The presence of periclinal folds in the Weald has been noted before (Wooldridge and Linton 1955). The western end of the anticlinal axis in the area under consideration (Fig. 2) acquires a south-east trend at Brightling. It has been suggested (Howitt 1964, p. 96) that the shallow anticlines through the Broadoak–Brightling and Hollingrove–Netherfield inliers are also *en-échelon*, but the fold axes shown on Fig. 2 indicate that this is not the case. There is insufficient evidence from the Archer Wood Inlier to prove an anticlinal structure of any importance.

Within the area of the Purbeck Beds inliers the folding is intimately associated with a zone of major faulting which is mainly responsible for these strata being at the surface. Generally steeper northern limbs to the anticlines and thrust faults that hade towards the south indicate that the formation of the dominant structures was controlled by pressures from the south; also the general east–west strike of folds and faults that changes in the east of the area to an east-south-east trend shows that the movement probably came from the south or south-south-west. That these movements affected most of the Jurassic strata is shown by evidence of reversed faulting of the Lias proved in one of the deep boreholes (p. 5). How deeply such faults affect the Palaeozoic basement rocks or whether there has been any reactivation along pre-Mesozoic structures is uncertain; the fact that the structural pattern is one of faulting rather than folding is probably due to the Purbeck and Hastings Beds generally being relatively competent strata. The earth movements were probably part of the Alpine orogeny which reached its peak during the late Oligocene–Miocene period.

The Burwash Common Fault (Fig. 2) is the most important fault in the area. It trends west to east at Burwash Common where it turns to an east-south-east trend and branches just north of High Wood [6640 2349] where a borehole [6654 2314] (Geological Survey No. 303/179; Borehole 37 on Plate I) proved it to be a reversed fault. The normal thickness of Purbeck Beds in this region is about 480 ft but here it was recorded as 828 ft. The fault at this point hades at about 15° south and has a throw of about 340 ft. At depth the hade may increase to 30°–40°, for in a borehole [6726 2182] (319/309; Borehole 1 on Plate I) near Coombe Wood a reversed fault was proved in Liassic strata at 3600 ft. This fault throws about 600 ft and is probably associated with the Burwash Common Fault but may lose some of its effect in the Kimmeridge Clay, as

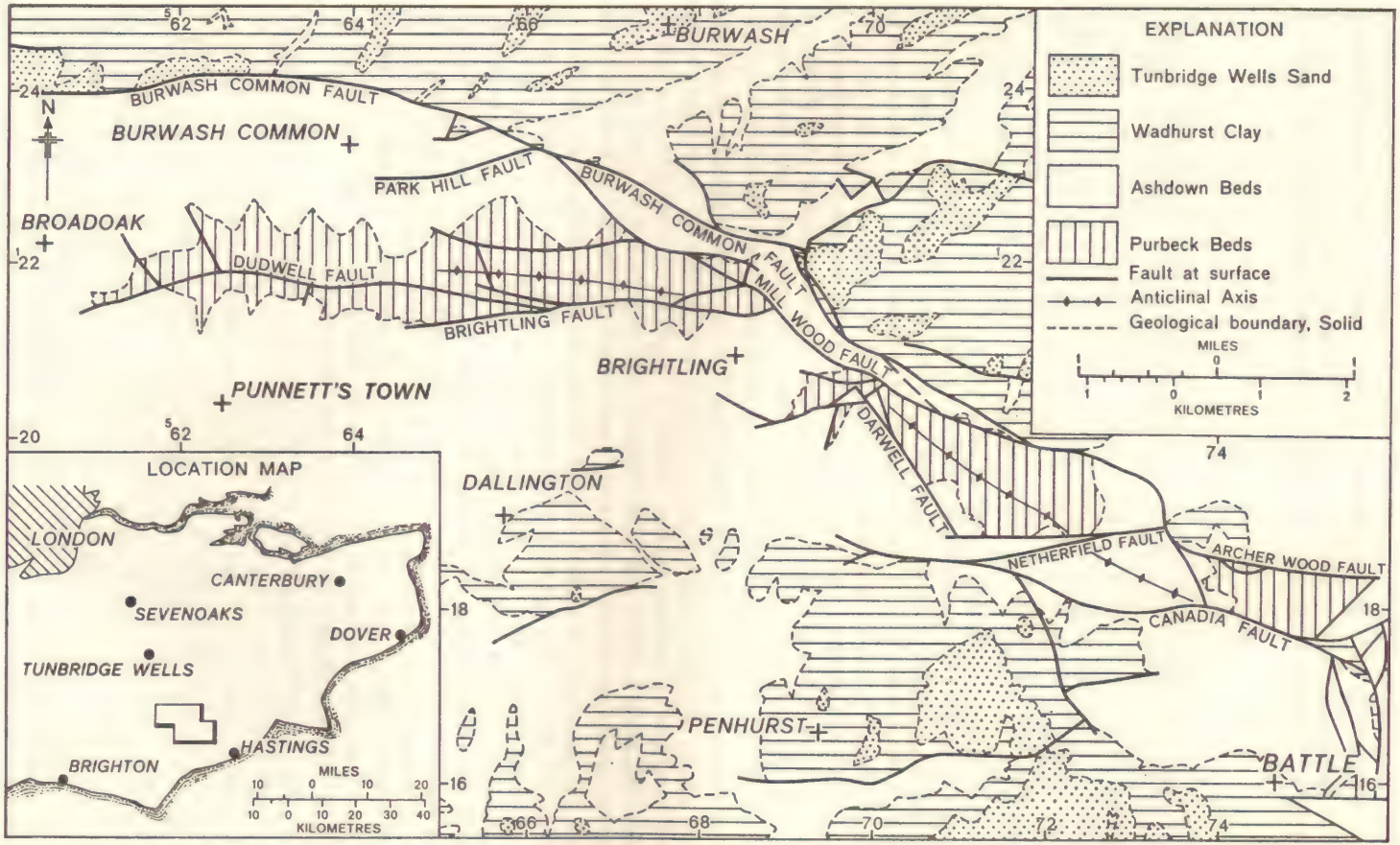


FIG. 2. *Sketch-map showing the general geology and major structural features of the district*

suggested by Howitt (1964, p. 101). The Burwash Common Fault passes to the north of a borehole [6870 2230] (304/101) where a record of 697 ft of Ashdown Beds (Shephard-Thorn and others 1966, p. 27) probably indicates reversed faulting. Although the thickness of the Ashdown Beds is said to be unlikely to exceed 450 ft in the south-west of the Tenterden (304) Sheet (op. cit., p. 27) recent borehole information suggests that within the area of Fig. 2 it is over 550 ft and is possibly nearer 650 ft (p. 21).

The Burwash Common Fault joins a small area of complex faulting east-north-east of Brightling (op. cit., p. 18) and following a sinuous course joins the Mill Wood Fault in Darwell Wood (Plate IV). The area north of the Mill Wood Fault between Great Wood (Plate I) and Darwell Wood has been mapped by Edmonds. It is likely that the two Wadhurst Clay inliers just north of the fault in Darwell Wood have been caught up in the major zone of faulting that the Burwash Common Fault probably represents. Any faults that at the surface have Ashdown Beds on both sides are difficult to trace in the field because of a lack of recognizable horizons in most of the Ashdown Beds sequence. It is therefore probable that the single line which can be followed where other strata are involved represents only part of a major fault zone and the two Wadhurst Clay inliers are thrown against Purbeck Beds indicating that the fault has a throw of 600–700 ft. It is likely that there is a fault that could not be traced at the surface but which makes up to the south-west side of the Burwash Common Fault zone and joins this in a manner indicated by the broken line on Fig. 2. The total throw of the fault within this narrow fault zone increases towards the east; north of Limekiln Wood the Wadhurst Clay crops out against the Middle Purbeck and similarly in Hucksteep Wood an outlier of Wadhurst Clay is near the outcrop of Purbeck strata.

Through Hucksteep Wood the fault swings sharply to the south and then returns to its original trend through Archer Wood where it is called the Archer Wood Fault. A borehole [7455 1840] (320/127) just south-east of Archer Wood produced questionable results but rocks of Purbeck lithology were reported to 700 ft. This suggests the possibility that the Archer Wood Fault is a reversed fault and, as is shown (Fig. 2), that it is a continuation of the Burwash Common Fault. The swing through Crowhurst and Hucksteep Woods (Plate I) is spectacular, but unless both these faults with throws from 500–700 ft die out in less than 400 yd it is considered probable that they are part of the same fault zone. There may have been some lateral movement along the north to south trending part of this fault, the fault plane here possibly being nearly vertical and the hade of the Archer Wood Fault being less than that of the Burwash Common Fault.

The Purbeck Beds of the Archer Wood Inlier seem to be almost horizontal and there is certainly not enough evidence to prove a major anticlinal structure. Only two boreholes have been drilled with definite results and one of these is near, and so may be affected by, the small fault trending north-north-west through Goldspur Wood. This fault has a throw to the west of about 100 ft. The Archer Wood Fault has a throw of 500–600 ft. A wedge of Lower Purbeck, the Blues Limestones, has been caught up on this major fault and makes a small faulted inlier within the Upper Purbeck Greys Limestones [7420 1850] (Fig. 3, section 1).

The Mill Wood Fault (Fig. 2) has a throw of little more than 50 ft through High Wood. It joins a minor east to west trending fault that passes through Perch Hill and continues through Chilley's Wood to Great Wood (Plate I) where there is a small fault block, all the faults having throws of less than 100 ft (Fig. 3, section 2). This fault forms the eastern side of the Broadoak–Brightling Inlier and continues in an east-south-east direction until it joins the main Burwash Common Fault zone.

The Dudwell Fault (Fig. 2) trends almost due west to east and has a maximum throw of just over 100 ft south of Nine Acre Wood [6360 2175]. It should be noted that the apparent faulting near the centre of the Dudwell Valley may be accentuated by valley bulging (p. 13). This fault cannot be traced west of Gameland Wood, where its throw is not more than 40 ft. Some minor fractures are associated with it, for example in Tottingworth Park and Green Wood (Plate IV). In the east the Dudwell Fault almost fades out before joining the Brightling Fault.

The Brightling Fault (Fig. 2) trends west to east with the throw decreasing towards the west. Between Glazier's Forge and Coombe Wood the throw is less than 100 ft but in Rounden Wood it increases (Fig. 3, section 2) and ends against the Mill Wood Fault north-north-east of Brightling. The Dudwell and Brightling faults throw down to the south and are probably normal. The presence of several minor faults within the inlier between Blackbrooks and Great Wood indicates the possibility of more minor faults, probably generally trending north-west to south-east. At the surface these could not be accurately traced but spring lines sometimes suggested their presence, for example within Coombe Wood. Similar minor faults have been described (Sherlock and Hollingworth 1938) from the mine-shafts in the Hollingrove–Netherfield Inlier, where there is a system of small parallel faults with a maximum throw of about 7 ft trending a few degrees east of north. These minor faults die out away from the anticline crest. No evidence was found to substantiate a transcurrent fault through Glazier's Forge (Howitt 1964, p. 112). It is certainly possible that there is a small flexure in the folding on an approximately north to south axis in this area, possibly accentuated by the faulting in Blackbrooks, but evidence of lateral movement along a north-east trending fault was not discovered.

At the western end of the Hollingrove–Netherfield Inlier (Plate IV) there is a complex zone of faulting in which wedges of Ashdown Beds are faulted down against Lower Purbeck Beds. The northern edge is the Mill Wood Fault and the southern edge a fault trending west-south-west with a throw of up to 300 ft. This southerly fault is probably normal; a borehole [6912 2020] (320/131) just north of Cackle Street passed through the Purbeck Beds at a depth of about 900 ft directly into the Kimmeridge Clay.

The Darwell Fault (Fig. 2) trends south-east and has a throw of less than 50 ft. The southern boundary fault of the Hollingrove–Netherfield Inlier similarly has a small throw of about 50 ft to the south which decreases towards the east. The Goldspur Drift [7280 1895] only indicated a series of very small faults within the one fault zone and where it meets the major Archer Wood Fault in Hucksteep Wood the throw is very small. The Netherfield Fault to the west is more important, throwing about 400 ft to the south near Netherfield, as proved by two boreholes [7176 1868 and 7177 1860] (320/192 and 320/126; boreholes 65 and 22 on Plate IV). The major fault passes just south of Darwell

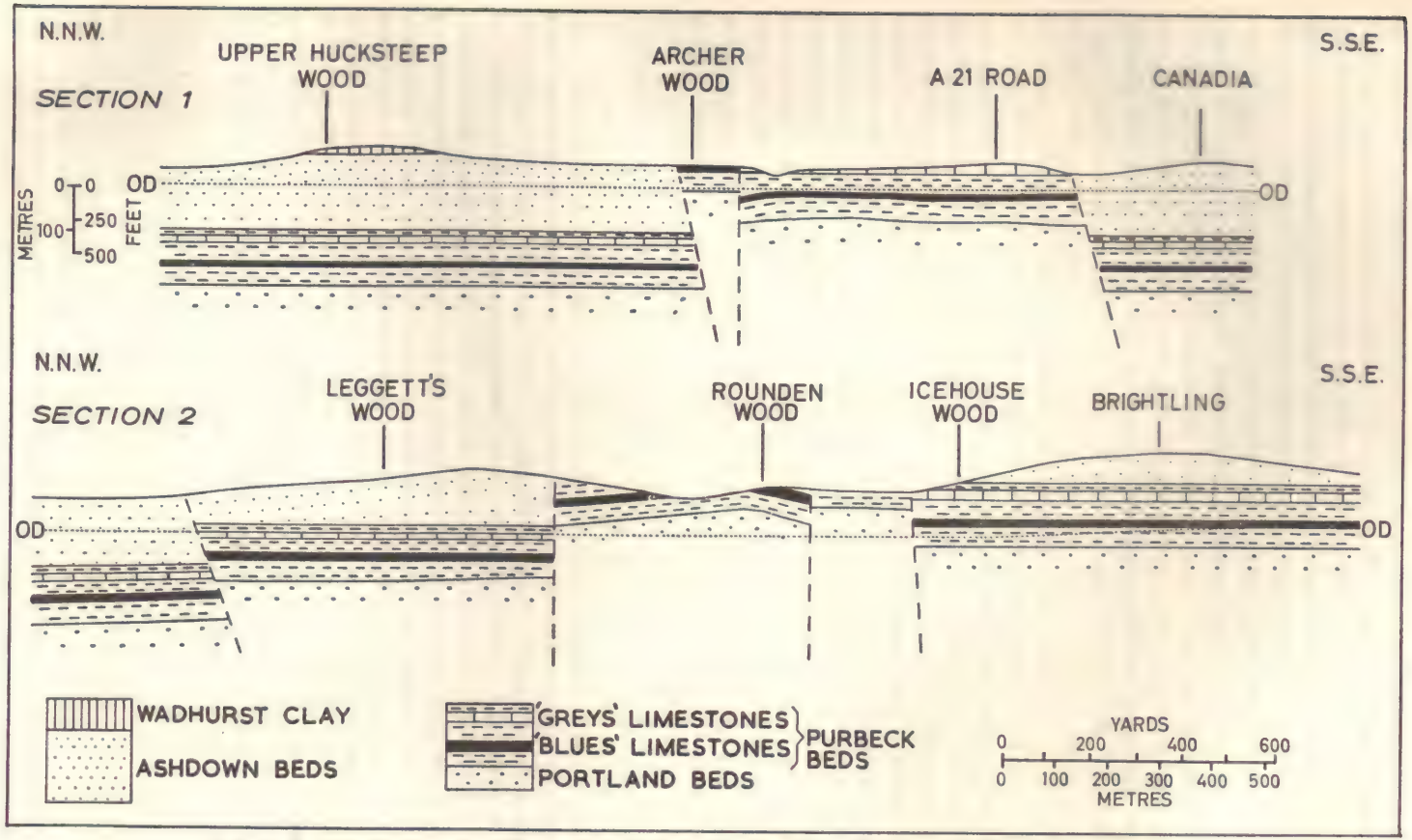


FIG. 3. *Vertical sections illustrating the general structure of the Purbeck inliers in the Weald*
For line of sections see Plates I and IV.

Hole but in Netherfield it branches to trend almost east-south-east and form the southern boundary fault of the Archer Wood Inlier. Near Canadia this fault has a throw of at least 600 ft, for Wadhurst Clay is thrown against Upper Purbeck. The Purbeck of the Archer Wood Inlier is terminated by a south-south-west trending fault passing near Ringlett's Farm.

Generally the Purbeck Beds within these inliers are confined by major faults along the northern and southern boundaries. Whilst the presence of minor faulting along the crest of the anticline will always be a problem in mining, the most promising area for future resources of gypsum and anhydrite is obviously within the Broadoak–Brightling Inlier, particularly at its western end between Poundsford and Broadoak.

Stratigraphy

The sediments and general stratigraphy

The base of the Purbeck Beds is not seen at the surface in Sussex. When cored in boreholes it is easily distinguished from the Portland Beds, the top of the latter being a calcareous sandstone whilst above are the gypsiferous limestones and shales of the Lower Purbeck. With the wealth of borehole information available this datum can be accurately traced throughout the area (Howitt 1964, pl. 4). In the present work the Purbeck Beds not cropping out at the surface have only been studied in detail as regards the microfauna. In the mine shafts the rock surfaces are now mainly concealed and most of the borehole cores were not available for examination. Details of this lowest part of the Purbeck Beds, just over 60 ft thick, are given by Howitt (1964). Generally there are four main seams of gypsum and anhydrite in the basal beds of the Purbeck in this district, the first being very close to the top of the Portland Sandstone. These, associated with silty limestones, calcareous shales and secondary chert nodules, make up approximately the basal 50 ft of the formation.

Above the gypsiferous beds are about 100 ft of calcareous shales and argillaceous limestones (Fig. 4). The limestones in this part of the sequence have been variously named (Topley 1875; Howitt 1964, fig. 1), from the base upwards, as the Mountfield Adit Limestone, Icehouse Limestone, Dunk Shaws, 3rd, 2nd and 1st Rounden Greys and Bastard Blues. These limestones are described in more detail later; generally they are finely crystalline and full of ostracod and bivalve shells. Some are limestone conglomerates with small pellets and clasts of calcareous mudstone (Plate III, fig. 3). Algal limestones (Plate II, fig. 1) are common at this level but are rarely found higher. In the Bastard Blues, limestone becomes more common towards the top of the beds to which the Blues Limestones, about 40 ft thick, form a cap. The Blues Limestones consist of calcareous mudstones and limestones that are usually highly crystalline (Plate II, fig. 4) and sometimes nodular. Shells, including those of bivalves, gastropods and ostracods, are very abundant.

Immediately above the Blues Limestones, taken as the top of the Lower Purbeck (Fig. 4), the succession is dominated by mudstones that are calcareous near the base. Plant and bone-beds have been reported as common in mine sections (Howitt 1964, p. 84) but surface exposures in this part of the sequence are poor, probably due to its relative lack of hard rock layers. About 40 ft above the base of the Middle Purbeck is a series of limestones and calcareous shales, about 5 ft thick, which sometimes contains *Liostrea distorta* (J. de C.

Sowerby). This is known as the 'Cinder Beds horizon' and can be correlated with the well-known Cinder Beds of the Middle Purbeck in Dorset. Above the 'Cinder Beds horizon' are over 100 ft of rhythmically deposited argillaceous limestones, shales or mudstones, silts and sandstones. Shells are common all through the sequence. The sandstone member at the top of each rhythm becomes more important upwards and the top of the last thick sandstone is taken as the top of the Middle Purbeck. This horizon is easily mapped and can be traced throughout the district.

The lower division of the Upper Purbeck, the Greys Limestones, generally consists of dark grey mudstones, shales and limestones. The limestones are usually argillaceous, fossiliferous and are very distinctive (Plate II, fig. 3), particularly when compared with the more crystalline and less shelly limestones of the Blues Limestones group. The Greys Limestones are associated with tough leathery 'paper' shales. In the basal 20 ft of the group limestones are not so common, the sediments being dominantly of mudstone with clay-ironstone nodules. The number of limestone horizons increases upwards. The top is taken as the last appearance of shelly limestone and paper shales. This division of the Upper Purbeck is about 70 ft thick. The upper division of the Upper Purbeck is poorly exposed throughout the area and consists mainly of medium grey mudstone with subordinate silts, sandstones and nodular clay-ironstones. That mudstone is the dominant lithology probably accounts for the lack of good exposures. The mudstone weathers to a light grey or brown clay. This division of the Upper Purbeck is 40 to 60 ft thick.

The clay at the top of the Purbeck Beds was traced, independently of the palaeontological work, on strictly lithological grounds. It was later found that the top of this clay coincides approximately with the position of the top of the Upper Purbeck as based on ostracod evidence (Fig. 4). It must be stressed that the mapping of these inliers was completed using changes in lithology to position boundaries. When the ostracod zonation was complete it was found that the lithological boundaries coincided closely with the standard ostracod zonation (Anderson 1940) into Lower, Middle and Upper Purbeck. Thus the use of these faunal divisions on the map is shown to be completely justified for the first time within the Sussex area. Howitt (1964), having inadequate palaeontological evidence, placed his Purbeck divisions in parentheses. His 'Lower' Purbeck is equivalent to the Lower Purbeck in this work, but the top of his 'Middle' Purbeck is taken about 20 ft higher than the Middle Purbeck here and his 'Upper' Purbeck is only equivalent to the lower part, the Greys Limestones, of the Upper Purbeck (Fig. 4).

The macrofauna of the Purbeck Beds in Sussex is composed almost entirely of bivalves and gastropods. These have not been studied in detail but commonly include *Neomiodon sp.*, *Corbula sp.*, *Unio sp.* and *Viviparus sp.* Fish remains are present throughout the Purbeck Beds and plant remains are common. Vertebrate bones have been found in the gypsiferous series at the base of the Lower Purbeck (Pugh 1954, p. 20; Howitt 1964, p. 83). Algae are present in the Lower Purbeck; the abundant microfauna throughout the Purbeck Beds is effectively dominated by the ostracods.

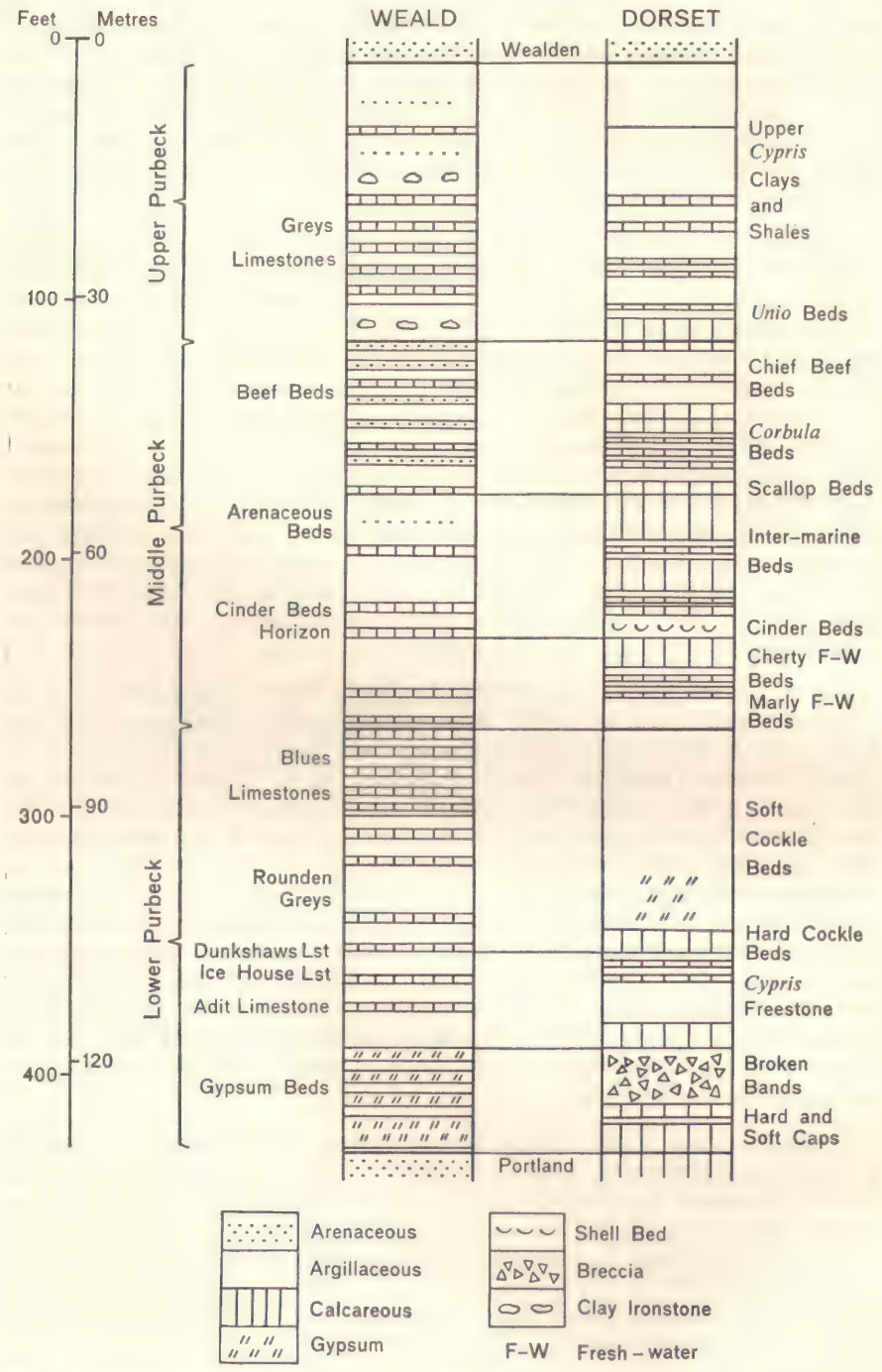


FIG. 4. *Generalized lithological sequence and main divisions of the Purbeck Beds in the Weald compared with those of Dorset*

IMPORTANT SURFACE EXPOSURES

There are many small exposures within the three main Purbeck Beds inliers. Only those of importance in illustrating the type of sedimentation from each part of the sequence are mentioned below. The inliers and their details are described in turn from west to east for ease of reference.

Broadoak–Brightling Inlier (Plate I)

At the western end of the inlier in the deep valley of the River Dudwell the strata are strongly contorted because of valley bulging. In sections of the lowest Ashdown Beds in the River Dudwell through Gameland Wood [6084 2147] sandstones and silts are common. In Church Wood there are contorted grey mudstones [6102 2158] from the Upper Purbeck clay, and downstream horizons are exposed within the Greys Limestones, but there has been landslipping from the steep hillside to the south which has brought Ashdown Beds sandstones into the river [6140 2162].

In the four tributaries of the River Dudwell which flow through Milkhurst Wood, Ten Acre Wood, Nine Acre Wood and west of Westdown there are many small exposures of Upper and Middle Purbeck Beds. In the deep ravines valley bulging and possibly cambering is pronounced, causing the rocks to have anomalous surface dips at many places. For this reason a continuous measured section through the Purbeck Beds was not possible; but some individual outcrops give an idea of the typical lithologies making up the various divisions. In Milkhurst Wood, below a series of small exposures of thin sandstones in clays (Upper Purbeck) there are good sections in the Greys Limestones. The sequence just above a small bridge over the stream [6227 2242] reads: paper shale and thin shelly limestones, 1 ft 3 in; resting on shale, medium grey, 3 ft; on limestone, argillaceous, shelly, 3 in; on shale, medium grey, shelly (some layers packed with shells many of which are still articulated), 3 ft.

About 100 yd downstream there is a section [6233 2236] at the top of the Middle Purbeck which shows much of one of the typical sedimentary rhythms. This reads: sandstones, calcareous, and sandy shales, thinly bedded with load casts and washouts, plant remains abundant, 9 ft; on shale, dark grey, carbonaceous, 2 in; on sandstone, buff, massive with load casts and channelling at base, 1 ft; on shale, medium grey, 1 ft; on shale, medium grey, calcareous, 10 in; on shale, light to medium grey, with a few bivalve shells, 2 ft.

A similar rhythmic sequence, usually with the rhythms started by thin argillaceous limestones and followed by medium grey shales with plant remains and then silts and sandstones, is present downstream. In a good exposure just below [6249 2222] the sequence is:

	Ft	*in*
Sandstone, calcareous, light grey to brown	2	6
Shale, dark grey, carbonaceous; top 4 in very coaly	0	11
Shale, medium grey; rare shells	2	1
Shale, medium grey; very shelly	3	0
Not exposed, thickness estimated	1	0
Shale, medium grey, very shelly, on light grey calcareous muds with few shells	6	0
Calcilutite, light grey weathering brown	0	3
Shale, medium grey, shelly	0	4

	Ft	*in*
Not exposed, thickness estimated	4	0
Shale, medium grey with nodular crystalline limestone 0 to 6 in ..	1	6
Shale, medium grey	0	6
Limestone, sandy; large bivalve shells; plant remains	0	2
Shale, dark grey; thin shell beds near base	1	9
Mudstone, light grey with nodules of crystalline light grey limestone 0 to 1 ft	5	6
Shale, medium grey	0	6

The Cinder Beds horizon was identified in the lowest 7 ft 9 in of this sequence by the ostracod fauna. From the lithology and macrofauna alone this horizon could not easily be distinguished (Bazley and Bristow 1965, p. 319). Farther downstream exposure is poor but at the junction with the River Dudwell, beds probably referable to the Blues Limestones, are exposed; similar strata are present at the junction of the tributaries from Ten Acre and Nine Acre Woods with the River Dudwell. Crystalline nodular limestones (Plate II, fig. 4) are present in layers varying from 1 in to 1 ft 1 in thick in light grey calcareous mudstones. These are associated with shelly medium grey shales, thin shelly limestones and occasional carbonaceous layers. It is possible that some of these strata belong to horizons slightly higher than the Blues Limestones and if this is the case the effect of the Dudwell Fault (Fig. 2) in the area is not very great; for in many sections to the south there are exposures [6271 2187] typical of the upper part of the Middle Purbeck.

In the Ten Acre Wood, Nine Acre Wood and Westdown tributaries there are many excellent sections in the Upper and Middle Purbeck Beds. Small exposures just above the Upper Purbeck clays show the light brown massive plant-containing sandstones and silts of the Ashdown Beds. In all streams cambering and valley bulging cause strong superficial folding. In the Upper Purbeck clay, thin sandstone beds with plants were noted [6289 2257] and there are bell-pits dug for the nodular clay-ironstone present just above the Greys Limestones. In each of the streams the very shelly argillaceous limestones (Plate II, fig. 3), paper shales and mudstones of the Greys Limestones are well exposed and below is a rhythmic upward sequence of thin limestone, shelly medium grey mudstone or shale grading up into silty shales with carbonaceous remains which in places form coaly seams immediately below an argillaceous sandstone. The basal limestone of each rhythm is not always present in the upper part of the Middle Purbeck and, at the top, the sandstones can be up to 6 ft thick. Lower in the Middle Purbeck the sandstone member of each rhythm tends to be less well developed and the limestones more common.

Below Poundsford there is a section [6359 2243] typical of the Greys Limestones sequence which shows: paper shales, dark grey, shelly, 1 ft; resting on limestone, medium grey, slightly sandy, argillaceous, shelly, 1 ft 5 in; on shale, medium grey, shelly, 2 ft 1 in; on limestone, medium grey, shelly, 1 ft 1 in; on shale, medium grey, shelly, 11 in; on limestone, medium grey, very shelly, 3 in; on mudstones, medium grey, shelly (including some shell layers), 4 ft; on limestone, medium grey, very shelly, 1 in. About 100 yd downstream is a massive current-bedded sandstone 5 ft thick with many carbonaceous remains; this is the top of the Middle Purbeck. Bell-pits at the side of the stream stop at this horizon but have worked about 50 ft of the strata above. Farther downstream [6369 2208] the rhythmic Middle Purbeck is exposed, showing: sandstone, grey,

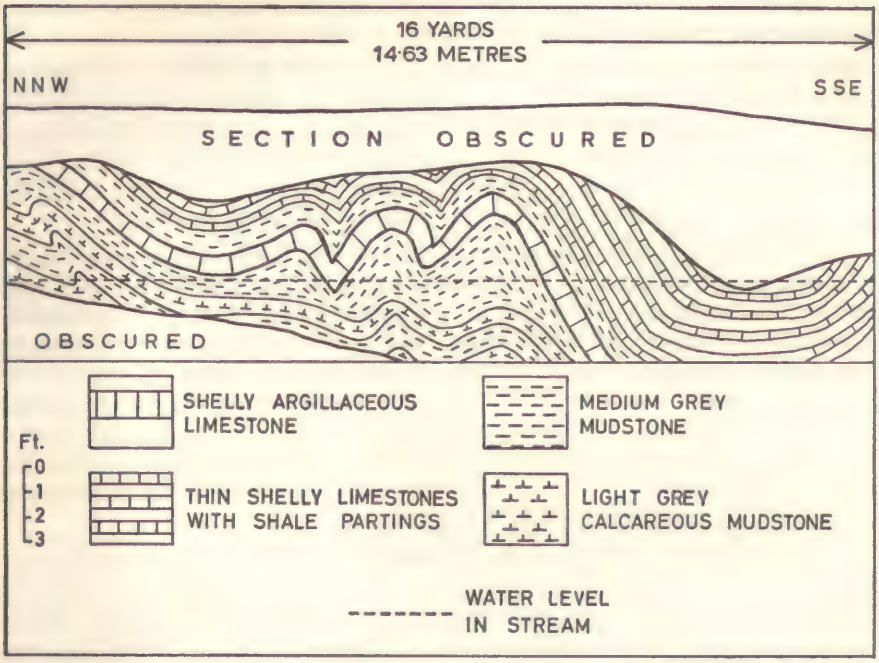


FIG. 5. *Diagrammatic view of valley bulged Upper Purbeck Beds exposed in the bank of the River Dudwell near Poundsford*

flaggy, 6 in; on shale, sandy, medium grey, 6 in; on shale, medium grey, 2 ft; on sandstone, grey, current-bedded, 4 in; on shale, sandy, medium grey, some shells, 11 in; on shale, dark grey, very carbonaceous near base, 2 ft 1 in; on sandstone, grey, 4 in. Just below these outcrops the Cinder Beds horizon has been identified from the microfauna (Plate I).

There are many small exposures of the upper part of the Middle Purbeck and the Greys Limestones in the main course of the River Dudwell. Most are severely affected by valley bulging of which there is an excellent example at Poundsford Ford [6385 2167] (Fig. 5).

In the tributary through Binglett's Wood there are good exposures of the Greys Limestones and also of the clay sequence above [6227 2145]. The latter outcrop shows: shales, dark grey with much secondary selenite, plant remains and a sharp break at the base, 2 ft; resting on mudstone, light grey, 1 ft 1 in; on mudstone, sandy, light grey, 8 in; on limestone, sandy with plant remains, 5 in; on mudstones, dark grey with plant remains at top, 11 in; on sandstones and shales interbedded, grading upwards into mudstone and with a sharp break at the base, 1 ft 1 in; on mudstone, light grey, 3 ft. This exposure indicates a rhythmic pattern of sedimentation in the upper part of the Upper Purbeck. A short distance upstream there are loose nodules of clay-ironstone.

Two boreholes near Westdown confirm the presence of the clayey part of the Upper Purbeck [6391 2222 and 6473 2241] (303/143 and 303/144; boreholes Bu 1 and Bu 2 on Plate I). The former started below the top of the Purbeck Beds and proved at least 20 ft of clay above the Greys Limestones, the re-

mainder of the Purbeck being 446 ft thick; the latter started in the Ashdown Beds but also indicated shales above the Greys Limestones.

In the eastern half of this inlier a borehole [6474 2142] (319/338; Borehole 32 on Plate I) starting at the top of the Greys Limestones 'proved' 511 ft of Purbeck Beds. Nearby [6544 2120] (319/302; Borehole 18 on Plate I) a borehole proved Ashdown Beds on a reported 438 ft of Purbeck Beds. The reported thickness differences of the Purbeck Beds illustrate the difficulty of fixing the Upper Purbeck Beds boundary in an uncored borehole (see p. 22).

Near Willingford there are many sections in the Greys Limestones that dip north-north-west at about 8° along Black Brook. At one locality the upper part of the more sandy Middle Purbeck is exposed [6595 2228]. In the forest of Blackbrooks extensive mining for the Greys Limestones has left the country pock-marked by old bell-pits. Streams issuing from the Greys Limestones or other calcareous horizons lower in the sequence are highly charged with calcium bicarbonate which locally forms patches of tufa [6538 2185]; this is found at many places in the area. Below the Greys Limestones in Blackbrooks the forestry drives are quite sandy, indicating the relatively high proportion of sand and silt in the upper part of the Middle Purbeck.

In Coombe Wood numerous small streams cut deeply into the Middle Purbeck and there is much local landslipping, especially near the southern boundary fault. Small springs indicate the possibility of local small-scale faulting that could not be traced at the surface. The Cinder Beds horizon has been reported from a locality here (Howitt 1964, p. 90) which was not found subsequently, probably because the section has degraded or been covered by a recent landslip. Some poorly preserved ostracods from levels lower than the Cinder Beds horizon suggested that there may be a small part of the Lower Purbeck exposed here. There are oil seepages within this wood and it is noteworthy that gas has been known at Heathfield for many years and has been reported in some borehole cores (op. cit., p. 83). A sandstone, light grey weathering to brown, and at least 9 ft thick, in the upper part of the Middle Purbeck, is exposed in a stream section in Coombe Wood [6698 2213]. Current-bedding, ripple-marks and mudcracks (Plate II, figs. 6A, 6B) are features of this sandstone. Plant remains are common and there are casts of bivalve shells on some surfaces.

In Rounden Wood are the oldest Purbeck Beds found at the surface. The Blues Limestones can be readily traced by the extensive bell-pitting. The typical crystalline bluish grey limestones with few shells are scattered over the surface and are exposed particularly well in the stream between Rounden Wood and Ashen Wood [6762 2163]. At the latter locality there are 10 ft of crystalline light grey limestones above buff coloured calcareous mudstone, in places shaly, with thin nodular limestones. In the limestones *Serpula* tubes and *Chara* stems are common. Algal limestones in which Dr. Anderson has identified *Girvanella pisolitica* Wethered (Plate II, fig. 1), are also present in this part of the succession. North of Icehouse Wood beds from below the Blues Limestones of the Lower Purbeck are exposed [6805 2146]. The soft mudstones are not seen, due to weathering, but several light grey limestones each up to a foot thick crop out. These are crystalline and shelly with a macrofauna chiefly of bivalves and gastropods. Ostracods are abundant (Plate III, fig. 1) and a feature of one of the limestones is the presence of mud pellets [6805 2146] (Plate III, fig. 3). This

limestone is slightly sandy and may be equivalent to the Icehouse Limestone (Howitt 1964, p. 83). This is not, however, the oldest limestone exposed and the amount of limestone with mudstone pellets found as debris in the area suggests that this lithology occurs through much of this part of the sequence. The other limestones are equivalent to the Rounden Greys (Topley 1875) but do not form features and cannot be traced as separate beds for any great distance.

In an easterly extension of Rounden Wood, along a path cut for the new cable-way linking the Mountfield and Brightling gypsum mines, the Blues Limestones are well exposed. One limestone in the middle of this sequence [6843 2152] contains fine layers at the top that are full of *Chara* stems and gyrogonites (Plate III, fig. 2). Abundant ostracod species include *Cypridea dunkeri* Jones, *C. tumescens* (Anderson), *Fabanella boloniensis* (Jones) and *Mantelliana cyrton* sp. nov.

Hollingrove–Netherfield Inlier (Plate IV)

In the much-faulted western end of this inlier part of the Lower Purbeck is well exposed in the Darwell Stream. Rhythmic sedimentation can be demonstrated, light grey limestones or very calcareous mudstones at the base of each rhythm grading up into less calcareous medium grey mudstones. Each rhythm is about 8 ft thick. The limestone at the base may contain bivalve and gastropod shells and is sometimes nodular. Rogen were noted by Dr. Anderson in one limestone [6992 2050]. The debris in this area commonly includes Lower Purbeck limestones with mud pellets.

North-east of Cackle Street a small inlier of Upper Purbeck is exposed in the Darwell Stream [6958 2004] where its presence is due to faulting. Strata above the Greys Limestones are exposed and the sequence at the locality given above is:

	Ft	*in*
Mudstone, medium grey, shaly with nodular ironstone layers; very weathered	4	0
Sandstone, calcareous, medium grey; plant remains common especially at base where there are large carbonaceous stems in channels into mudstone below	0	8
Mudstone, light grey, silty with small ironstone nodules	1	2
Clay ironstone, nodular	0	4
Mudstone, medium grey, silty	0	6
Clay ironstone nodules	0	4
Limestone, sandy; many plant remains; ostracods at base	0	1
Mudstone, medium grey; plant remains	1	3
Sandstone, calcareous, current-bedded, top ripple-marked; pebbles at base (Plate II, fig. 5); plants throughout, especially common at base; base channelled into mudstone below; fish remains common	0	8
Mudstone, medium grey, shaly; carbonaceous plant remains	1	0
Mudstone, light grey, calcareous, shaly	1	4
Mudstone, light grey, calcareous with thin ½-in limestones; ostracods common	1	2
Mudstone, medium grey; large bivalve shells	1	9
Clay ironstone	0	4

Explanation of Plate II

Fig. 1. Algal limestone, Lower Purbeck, 1080 yd 061° [6789 2182] from The Mount, W. of Brightling, Sussex. BZ 67. × 1.

Fig. 2. Shelly limestone from the Cinder Beds, Middle Purbeck. Includes *Liostrea sp.* River Line [7159 1908], 800 yd at 054° from Netherfield, Sussex. RAB 93. × ½.

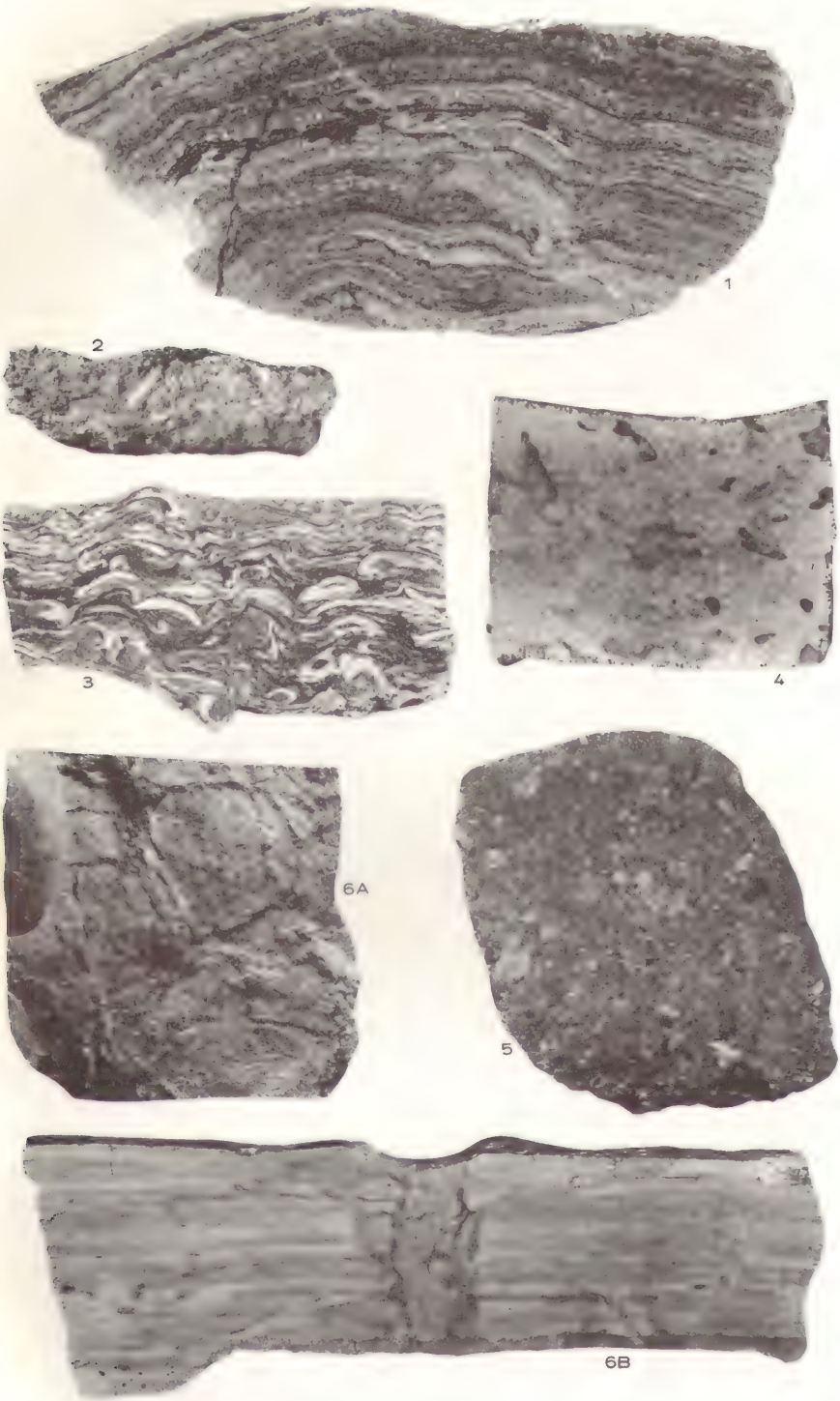
Fig. 3. Section through typical shelly limestone from the Greys Limestones, Upper Purbeck, 100 yd 220° [6359 2242] from Poundsford, S.S.W. of Burwash Common, Sussex. BZ 61. × 1.

Fig. 4. Section through calcilutite, dark patches caused by rusty-weathering concentrations of pyrite, Blue Limestones, Lower Purbeck, 870 yd 090° [6260 2197] from Tottingworth Park, E.N.E. of Heathfield, Sussex. BZ 62. × 1.

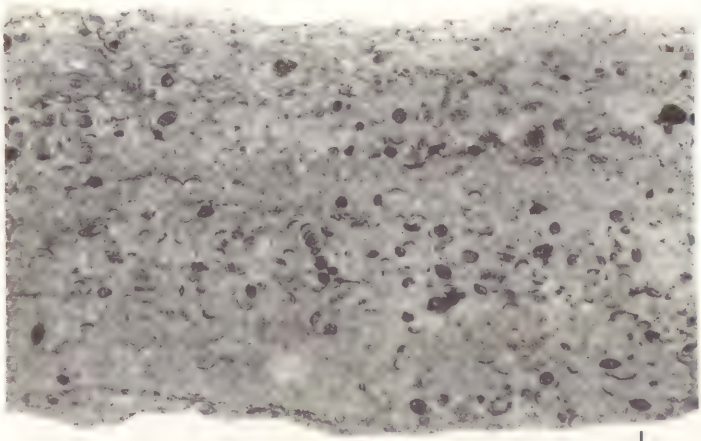
Fig. 5. Section through pebble bed in the Upper Purbeck, calcareous matrix with clasts of limestone and carbonaceous shale. The speckled appearance, particularly towards the top, is due to pyrite, 540 yd 050° [6958 2004] from Cackle Street and about 2000 yd at 135° from Brightling church, Sussex. BZ 53. × 1.

Fig. 6A. Mudcracks in silty limestone from the upper part of the Middle Purbeck. Under surface of specimen in fig. 6B, 860 yd 357° [6698 2213] from The Mount, W. of Brightling, Sussex. BZ 68. × ½.

Fig. 6B. Section of a mudcrack through finely laminated and current-bedded silty limestone. Dark shells are ostracods. Locality and specimen number as fig. 6A. × 1.



PURBECK LIMESTONES



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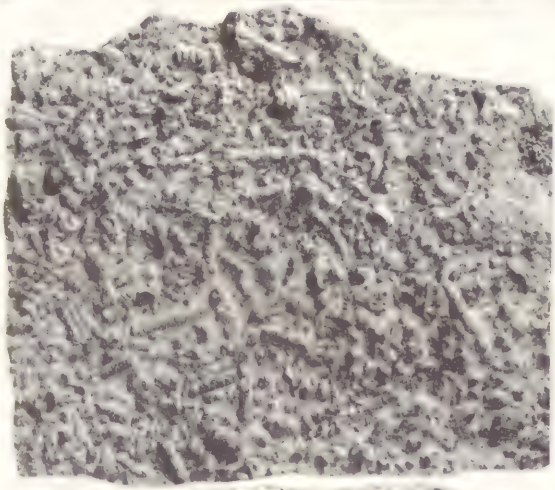

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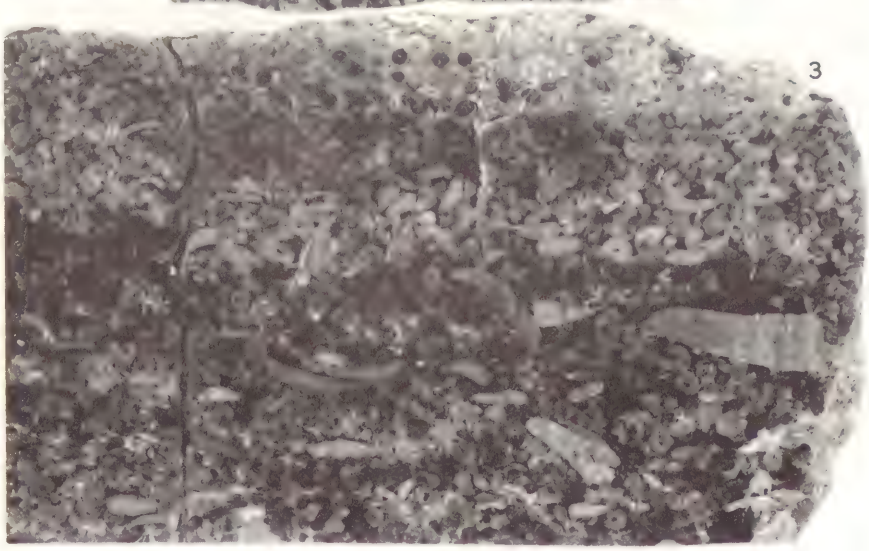


3

PURBECK LIMESTONES

The presence of much nodular clay ironstone is a feature of this part of the succession, as is the abundance of plant remains. A thin section from a clay ironstone nodule showed it to consist of spherulitic siderite. The plant-rich beds are comparable with those at Fairlight (Allen 1959, p. 289), but are probably rather lower in the succession.

In Darwell Wood the Blues Limestones are exposed [7073 2011] and there are many small outcrops of Middle and Upper Purbeck in forestry drives and streams. North of Netherfield there are good exposures in the River Line, particularly to the south-west of the Sub-Wealden borehole site (W 1 on Plate IV). The fine crystalline limestones and calcareous mudstones of the Blues Limestones are seen, as is much of the Middle and Upper Purbeck. The Cinder Beds horizon was proved at one locality [7159 1908] where the sequence is: mudstone, medium grey becoming more calcareous towards the base, 4 ft; resting on limestone, light grey, shelly, *Liostrea distorta*, 11 in; on mudstone, medium grey, shelly, many of the shells fragmentary, particularly at the base, 3 ft.

Sections described in the past (Howitt 1964) from the River Line where it passes through Limekiln Wood north-east of the Sub-Wealden borehole site are now no longer visible. The area has been levelled to provide the site for a new factory producing plaster-board.

Archer Wood Inlier

There are no good exposures in the Purbeck Beds in this inlier. The Blues Limestones and Greys Limestones can be traced by the many bell-pits at these horizons and they are mainly distinguished by examination of the resulting debris.

FURTHER NOTES ON THE CINDER BEDS AND MAIN LIMESTONE GROUPS

Although the top of the Upper Purbeck clay division is not always easy to fix at the surface, owing to superficial wash, most other boundaries within the Purbeck Beds can be closely traced. The Blues and the Greys Limestone groups are relatively massive and form distinctive features easily followed at the surface.

EXPLANATION OF PLATE III

FIG. 1. Section through ostracod limestone, Lower Purbeck, 580 yd 030° [6805 2146] from Brightling church, Sussex, BZ 63. × 2.

FIG. 2. Upper surface of limestone with *Chara* stems, Lower Purbeck, 570 yd 010° [6843 2152] from Brightling church, Sussex. RAB 33. × 2.

FIG. 3. Section through limestone pellet bed including ostracod shells, Lower Purbeck. Locality as for Fig. 1. BZ 64. × 2.

The presence of many old bell-pits and the resulting debris along their outcrop is a great aid to mapping. For this reason they are distinguished on the maps (Plates I and IV). These horizons have been almost worked out over large areas where near the surface, the limestone having been used until the end of the nineteenth century for agricultural lime and also for building and paving stones. Fine examples of the latter obtained from the Greys Limestones are to be seen in the grounds of Bateman's [6710 2380], a National Trust property to the south of Burwash. The bell-pits are very abundant and because the resulting ground is so uneven and stony it makes poor agricultural land and is usually covered by thick forest. Some bell-pits, but less numerous, were also dug within the Middle Purbeck and the Upper Purbeck clay. These were for limestone and/or ironstone.

The episode of increased salinity in the Middle Purbeck of Dorset is represented by the oyster banks known as the Cinder Beds. An equivalent horizon is present in Sussex and can be recognized by the microfauna (see p. 38). It is only about 5 ft thick, consists of interbedded mudstones and limestones, and usually contains a macrofauna that includes *Liostrea distorta* and *Protocardia sp.* At the surface it was proved at three localities (Plates I and IV). *L. distorta*, in the field the most easily recognized member of the fauna, was only found at one of these places (Plate II, fig. 2). This oyster is not unique to this horizon in the Sussex Purbeck but has been found at other levels (Howitt 1964, p. 86). The Cinder Beds horizon in Sussex has a lithology (p. 14) indistinguishable from much of the Middle Purbeck. With a fauna not easily recognizable in the field, no peculiar lithology and being too thin to make a good feature, this horizon could not be used as a datum on the maps. It must be noted here that this bed has been given particular significance by Casey (1963) who considers the marine influx is associated with the major earth movements that took place at the end of the Jurassic and the beginning of the Cretaceous. If this is accepted then the Cinder Beds horizon may mark the base of the Cretaceous (p. 24). Casey has proposed the names Lulworth Beds for the strata beneath this horizon and Durlston Beds for those above. It is unfortunate in Sussex that in terms of sedimentology and mapping the Cinder Beds horizon is not more distinctive. Whilst it is true that the upper part of the Purbeck is substantially 'Wadhurst' in facies the same can be said of much of the lower part of the Purbeck succession. In Sussex, on grounds of sedimentology alone, there is no justification for moving the Wealden boundary down to the Cinder Beds horizon. The evidence for the precise position of the Jurassic–Cretaceous boundary depends entirely on palaeontology. In this context details of the ostracod assemblages may prove to be important in equating the predominantly non-marine Purbeck and Wealden microfaunas with their marine equivalents on the continent.

THE ASHDOWN BEDS, 'FAIRLIGHT CLAYS' AND UPPER PURBECK BOUNDARIES

The Ashdown Beds consist dominantly of interbedded light coloured sandstones and silts. Some thin clay seams are present within the sequence but these generally cannot be traced very far on the ground. Much 'wash' at the surface is a problem accentuated in deep valleys such as those where most of the Purbeck Beds crop out. The sand and silt from the Ashdown Beds on the hillsides above has been moved down, by processes of normal erosion or soil creep, like a mantle over the junction with the Purbeck Beds. This wash tends to mask any

thin clays within the Ashdown Beds and cover the actual Purbeck–Ashdown Beds boundary. Another problem is the differentiation between clay and silt; the latter weathers a light brown colour and is the dominant sediment of much of the lower part of the Ashdown Beds.

In the Ashdown Beds in this area no true clay of any great thickness was found. This was suggested as likely from the small area studied by Edmonds (*in* Shephard-Thorn and others 1966, p. 23). It is probable that many of the records of clay in the Ashdown Beds are misidentifications of silt, hence the recording of great thicknesses of clay in some borehole logs (it is emphasized that the majority of these logs were not made, nor the samples seen, by the authors). The total thickness of the Ashdown Beds is variable, as might be expected in a series of strongly current-bedded sands and silts laid down under predominantly deltaic conditions (Allen 1959; Taylor 1963). Boreholes at Brightling Down [6616 2070 and 6630 2031] (319/303, 319/304; boreholes 19 and 20 on Plate I) suggest a minimum thickness of 500 ft for the Ashdown Beds; a borehole south of Darwell Hole [6960 1874] (320/178; Borehole A3 on Plate IV) started just below the base of the Wadhurst Clay and is logged as 640 ft of Ashdown Beds on 376 ft of Purbeck; a borehole north-west of Ashes Wood [7205 1785] (320/185; Borehole N2 on Plate IV) started just below the base of the Wadhurst Clay and is logged as 760 ft of Ashdown Beds on 337 ft of Purbeck Beds and another on the northern boundary of Ashes Wood [7300 1780] (320/186; Borehole N3 on Plate IV) gave a sequence of 40 ft Wadhurst Clay on 621 ft Ashdown Beds on 482 ft Purbeck Beds; in Hucksteep Wood [7399 1915] (320/161; Borehole 51 on Plate IV) a borehole was logged as 15 ft Wadhurst Clay on 645 ft Ashdown Beds on 295 ft Purbeck Beds. In all these records the base of the Purbeck Beds is probably accurate but its top may be unreliable for reasons given below; this may explain the apparent considerable variation of total thickness of the Purbeck Beds. Only from Borehole N3 (320/186) was core examined in detail for microfauna and the relative thicknesses in this are the most reliable. In any case these boreholes serve to indicate that the total thickness of the Ashdown Beds is probably not less than 550 ft anywhere in the area and in most places exceeds 600 ft.

The 40 to 60 ft of clay found just below the base of the Ashdown Beds is a distinctive horizon. Within the clay thin silt and sandstone beds are common; an important feature is the occurrence of clay-ironstone (sphaerosiderite) nodules, particularly a layer about 10 ft above the top of the Greys Limestones. Old pits at this horizon indicate that it was once mined. Ostracods show these beds belong to the Upper Purbeck. The generally light buff colour and sometimes mottled appearance of this clay at the surface are probably due to weathering and the effect of water percolating down through the Ashdown Beds. Above the Upper Purbeck clay thin clays, usually less than 10 ft thick, have been mapped at only five horizons within the Ashdown Beds. These could not be traced continuously over all the area. Two are near the base of the Ashdown Beds in Tottingworth Park (Plate I).

Within this district there now seems little justification for continuing the use of the term 'Fairlight Clays' as a discrete unit. The mapping has shown that true clays are not common at the base of the Ashdown Beds and do not form distinctive horizons. The lower part of the Ashdown Beds is certainly more silty than the upper part but the borehole records that give great thicknesses of

'clay' are probably misleading. Because of the lack of materials of economic importance within the Ashdown Beds cores have rarely been taken. It is unfortunate that the term 'Fairlight Clay' has been used (White 1928; Howitt 1964) to indicate or imply a distinct lithological unit. The original and correct term is 'Fairlight Clays' (Topley 1875); they were described from the coast at Hastings as a part of the Ashdown Beds with a proportion greater than usual of seams of mudstone or clay amongst an otherwise silty and sandy sequence. The oldest strata exposed along the cliff section near Hastings, at the crest of the so-called 'Fairlight Anticline' some 800 yd east-north-east of Lee Ness Ledge [8710 1120], are clay and mudstone beds up to a maximum thickness of 16 ft but these are interbedded with the sandstones and silts that are the dominant sediments. The precise position of this section in the Ashdown Beds sequence has yet to be determined from detailed surveys. Whilst the term 'Fairlight Clays facies' might still be justified to indicate a sequence within the Ashdown Beds that contains more mudstone or clay seams than normal, use of the term Fairlight Clays as a lithological unit at the base of the Ashdown Beds, at least within the area of Fig. 1, and probably elsewhere in Sussex, should be discontinued.

LOCAL VARIATION IN THICKNESS OF THE PURBECK BEDS

The Purbeck Beds of the Sussex inliers are generally about 480 ft thick. Howitt (1964) recorded a total figure of 440 ft for the Broadoak–Brightling Inlier which does not include the Upper Purbeck clays. Measurements derived from surface exposures are unlikely to be as accurate as those from borehole information and the exposures within mine shafts. But much of the borehole information in this area may also be rather uncertain regarding total thicknesses. Certainly in sediments of Purbeck type a good deal of variation in thickness might be expected. For instance Howitt (1964, fig. 2) has indicated the possibility of an erosion surface at the top of the No. 1 seam of gypsum in the Lower Purbeck. Also within the upper part of the Middle Purbeck the sandstones are current-bedded and in places washouts were noted, both indicative of strong current action and probable non-sequences. In this respect there are two particularly interesting boreholes [6839 2159 and 7194 1930] (320/172, 320/31; Borehole 15 on Plate I and W 1 on Plate IV) which started just below the base of the Blues Limestones and penetrated the Portland Sandstone at depths of 95 ft and 180 ft respectively. It is estimated that the thickness from the base of the Blues Limestones to the Portland Sandstone is 108 ft at the former locality just north of Brightling and 190 ft at the latter north of Netherfield. Unless there is some untraced faulting affecting the first of these boreholes this indicates a considerable variation in the basal part of the Purbeck Beds. From all the many boreholes in this area, about 150, it appears, however, that the total thickness of the Purbeck Beds as given in the logs varies haphazardly. No significant change in any direction can be proved. This variation may be more apparent than real as the drilling was primarily to check the gypsum and anhydrite seams at the base of the Lower Purbeck. There were usually only chippings from the higher divisions of the Purbeck succession and from these the exact boundaries of the various horizons are hard to fix. More accurate placing of boundaries would be needed to obtain a meaningful map of the thickness variations within the area of Fig. 1. Whilst the structures and sediments of the Purbeck Beds indicate a probability of local variation its manner and amount remain uncertain.

SEDIMENTARY HISTORY

The sedimentary environments of Purbeck and Wealden times have been outlined previously (Anderson and others 1967, p. 174). Throughout the Purbeck sequence sedimentation was rhythmic, and probably controlled by cyclic variation in climate (p. 28) and/or by minor epeirogenic oscillations such as those which may have affected the Lower Lias (Hallam 1960). The rhythmic sedimentary variation is mirrored by a change of the ostracod fauna from sequences dominated by forms tolerant of high salinity to others made up mainly of relatively fresh-water species. The link between the ostracod faunicycles and the sedimentary rhythms in the Wadhurst Clay has been shown to be very close (Anderson and others 1967, p. 175) but in the Purbeck it is less close. This appreciation of the variation of salinity adds a useful refinement to knowledge of water conditions and deposition in the lagoon.

After the Portlandian, which was an apparently normal marine period, differential uplift produced in Southern England a lagoon with restricted circulation of water. This resulted in conditions of increased salinity and the deposition of the evaporites that characterize the basal part of the Purbeck. Thin limestones and dark shales were also formed during this time and contain a fauna dominated by ostracods. Vertebrate bones, wood and algae (Brown 1963) are common. Anhydrite and gypsum are the principal evaporites. Secondary chert has also been noted (Howitt 1964). The problem of the original form of the sulphate in these beds has been investigated recently; it has been suggested that some was originally deposited as gypsum, although there has been much later alteration to anhydrite and then reconversion to secondary gypsum (West 1965). An interesting suggestion in comparing anhydrite at present forming along the Trucial Coast of the Persian Gulf with that of the Purbeck is that the deposits are largely diagenetic in origin. Some Purbeck sulphate-bearing beds are said to show a rhythmic repetition comparable with the sabkha cycles of sedimentation and diagenesis (Shearman 1966, p. 211).

After the hyper-saline evaporite phase, conditions clearly became less extreme, probably because of increased water circulation due to a general deepening of the waters in the lagoon. There was probably an influx of water and increase in current strengths. This may account for minor wash-outs and non-sequences immediately above the evaporite series. Locally these wash-outs probably extend sufficiently far downwards to reduce or even cut out beds of the upper gypsum horizons. Howitt (1964, fig. 2) indicates such a minor non-sequence affecting the upper (No. 1) seam of gypsum in the Gypsum Mines Main Adit. Under these conditions calcareous shales were predominant, with occasional limestone beds such as the Mountfield Adit Limestone, Icehouse Limestone and Rounden Greys. The study of ostracods shows that sedimentation at this time was cyclic, as elsewhere in the Purbeck, and that these cycles reflect changes in salinity. Carbon isotope ratios of limestones and fossil carbonates (Allen and Keith 1965) confirm the conclusions drawn from the ostracod faunicycles, i.e. that there was great variability of salinity. In this respect the bivalves and gastropods throughout the Purbeck are uncertain indicators of salinity (Anderson and others 1967, p. 191). There is no positive evidence of limnitic conditions within the Purbeck Beds and in general the salinities probably varied mainly within the mixohaline range.

In the limestone beds of the Lower Purbeck mud pellets and shards are common (Plate III, figs. 1 and 3). These indicate relatively active currents for

at least short periods. Towards the top of the Lower Purbeck limestones were more commonly formed, the Bastard Blues (Howitt 1964, fig. 2) being followed by the main Blues Limestones. The limestones of the Blues Limestones are generally calcilutites (Plate II, fig. 4). They suggest relatively still, and possibly slightly deeper, water conditions.

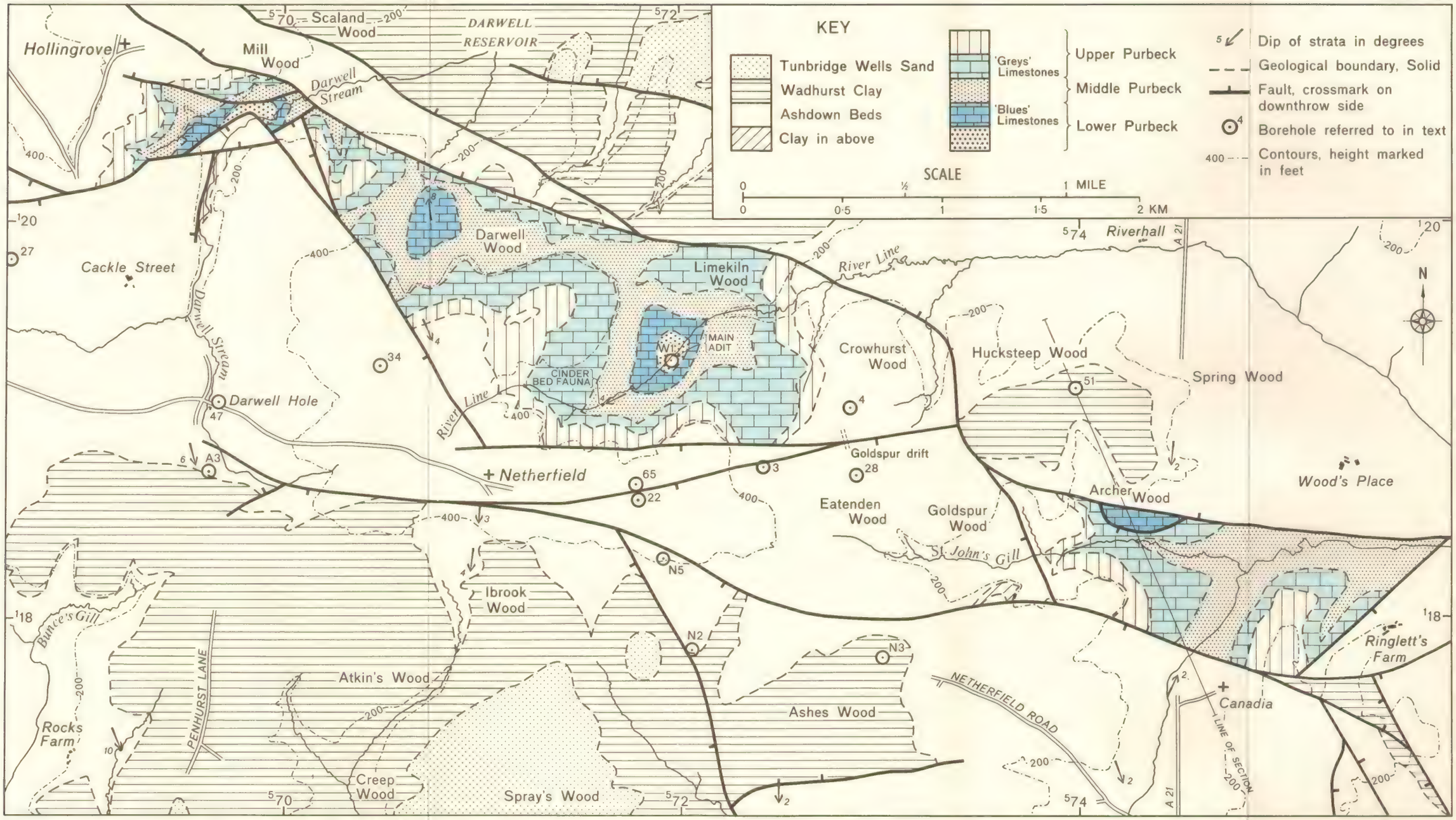
After the Blues Limestones there was deposited a rhythmic series of shales and silts with thin limestones; it contains plant and bone-beds (Howitt 1964, p. 84). Minor non-sequences suggest fairly shallow-water deposition and possibly even occasional emergence.

The well-known Dorset Cinder Beds, in the middle of the Middle Purbeck, are not as readily recognizable in Sussex. Here they form simply a group of thin shelly limestones and calcareous shales with *Liostrea distorta* as a distinctive member of the fauna. There is no doubt that this horizon represents a phase of relatively high salinity, but the presumed marine *Liostrea sp.* is by no means confined to this level (Howitt 1964). With the evidence of varying salinity from the microfauna, from carbon isotope ratios (Allen and Keith 1965) and from boron (Walker 1964), and with the presence of 39 proved faunicycles throughout the Purbeck, it is difficult to gauge what special significance in Sussex the Cinder Beds episode of increased salinity may have. In Sussex it is not marked by a non-sequence and can really only be rated as one of several major episodes of increased salinity. Casey (1963) and Casey and Bristow (1964) have, however, adduced strong arguments from palaeontology and stratigraphy in favour of the view that the base of the Cinder Beds should be taken as the base of the Cretaceous (Ryazanian).

Above the Cinder Beds horizon there is a well-developed sequence of sedimentary rhythms, each generally starting with a shelly limestone and grading up through shales to current-bedded sandstones and possibly a 'soil' above. The sandstone member of each rhythm becomes better developed upwards, possibly due to the water having become shallower and to the influx of more arenaceous detritus into the basin by rivers eroding the presumably rising land surface. The precise direction of derivation of these sands is uncertain, but the Wealden basin may have received detritus from land situated to the south-south-west in the Brittany area of France as well as from a land mass to the north and north-west (Allen 1967, fig. 7).

After the last major sandstone at the top of the Middle Purbeck, shales were deposited, with the formation of thin beds of nodular clay-ironstone, probably secondarily during early diagenesis of the sediments. This was succeeded by the rhythmic deposition of limestones and calcareous shales with thin sandy beds. These limestones are very shelly (Plate II, fig. 3) and were probably formed in slightly deeper and less active water. The typical presence of leathery 'paper' shales also suggests relatively still-water conditions but the abundant fauna shows that the water above the sea bed was well oxygenated. During the later stages of the Upper Purbeck clay was the dominant sediment, with occasional thin limestones, silts or sandstones and beds of clay-ironstone nodules. Rhythmic deposition was still a feature of these clays, which may generally indicate relatively deep-water conditions. The rhythms grade upwards into a sequence dominantly of silts and massive current-bedded sandstones that rarely contain preserved organic remains; these are the basal part of the Ashdown Beds. In the Ashdown Beds deltaic conditions probably prevailed (Anderson and others

1967, p. 174) but persisting minor rhythms of deposition can be traced right through to the succeeding Wadhurst Clay. Within the Ashdown Beds it is, in contrast with the Purbeck Beds, the arenaceous member of each cycle that is best developed. Throughout the Purbeck variation due to rhythms was, as referred to above, presumably caused by shallowing and deepening of the water in the lagoon, controlled by minor epeirogenic oscillations and climatic variation. There must have been at all times a very fine balance between fresh water pouring in from the rivers and sea water in the lagoon. The resulting fluctuations in depth, salinity, temperature, turbidity, food supply, etc. enabled certain members of the micro- and macro-faunas to flourish but it was rarely that truly marine forms could exist.



GEOLOGICAL MAP OF THE HOLLINGROVE–NETHERFIELD AND ARCHER WOOD INLIERS OF THE PURBECK BEDS

Part II

THE OSTRACODS

BY

F. W. ANDERSON, D.Sc., F.R.S.E.

OSTRACOD ZONES AND FAUNICYCLES

OSTRACOD ZONES

THE FIRST attempt at a zonal subdivision of the Purbeck Beds was that of Lyell (1855) who assigned the then known ostracod species as follows:

Upper Purbeck—*Cypris gibbosa*, *C. tuberculata*, *C. leguminella*.

Middle Purbeck—*C. striatopunctata*, *C. fasciculata*, *C. granulata*.

Lower Purbeck—*C. purbeckensis*, *C. punctata*.

The present-day nomenclature of these species would probably be:

Cypridea propunctata (*Cypris gibbosa*), *C. tuberculata adjuncta* (*C. tuberculata*), *Darwinula leguminella* (*C. leguminella*); *Macrodentina mediostricta* (*C. striatopunctata*), *Cypridea granulosa fasciculata* (*C. fasciculata*), *C. granulosa granulosa* (*C. granulata*); *Mantelliana purbeckensis* (*C. purbeckensis*), *Cypridea peltoides peltoides* (*C. punctata*).

In a letter to Bristow (?1851) Forbes gave:

Upper Purbeck—*Cypris spinosa* (probably *C. granulosa adjuncta*), *Cypris gibbosa* or *valdensis* (probably *C. propunctata*), *Cypris leguminelloides* (*D. leguminella*).

Middle Purbeck—*Cypris granulosa* (*C. granulosa granulosa*), *C. fasciculata* (*C. granulosa fasciculata*), *Cypris striatopunctata* (*Macrodentina mediostricta*), large form of *C. leguminelloides* (*Darwinula oblonga*).

Lower Purbeck—*C. purbeckensis* (*Mantelliana purbeckensis*).

In 1885 T. R. Jones gave a more extensive list as follows:

Upper Purbeck—*Cypridea punctata* (*C. propunctata*), *C. punctata* var. *gibbosa* (not identified), *C. punctata* var. *posticalis* (*C. posticalis* does not occur in the Upper Purbeck; Jones may have confused this species with *C. alta formosa*), *C. dunkeri* (may have been confused with *C. varians*, *C. dunkeri* does not occur in the Upper Purbeck), *C. ventrosa* (*C. ventrosa*, a rare species), *C. tuberculata* var. *adjuncta* (*C. tuberculata adjuncta*), *Cyprione bristovii* (*Darwinula oblonga*), *Darwinula leguminella* (*D. leguminella*).

Middle Purbeck—*Cypridea valdensis* (probably *C. obliqua*, *C. valdensis* is a Weald Clay species), *C. dunkeri* (*C. dunkeri*), *C. punctata* (?*C. propunctata*, but more probably *C. amisia* or *C. inaequalis*, *C. propunctata* is not a common form in the Middle Purbeck), *C. punctata* var. *gibbosa* (not identified), *C. punctata* var. *posticalis* (*C. posticalis*), *C. ventrosa* (probably *C. peltoides eurygaster*, *C. ventrosa* is a rare form found only in the Upper Purbeck), *C. ventrosa* var. *globosa* (not identified), *C. tuberculata* (*C. tuberculata langtonensis*), *C. granulosa* var. *fasciculata* (*C. granulosa fasciculata*), *C. granulosa* var. *paucigranulata* (probably a variety of *C. granulosa fasciculata*), *Cyprione bristovii* (*Darwinula oblonga*), *Darwinula leguminella* (*D. leguminella*), *Metacypris forbesii* and var. *verrucosa* (*Theriosynoecum forbesii*).

Lower Purbeck—*Cypris purbeckensis* (*Mantelliana purbeckensis*), *Candona bononiensis* (*Fabanella boloniensis*), *Candona ansata* (*Fabanella ansata*), *Cythere transiens* (*Macrodentina transiens*), *Cythere retirugata* (*M. retirugata*), *Cythere retirugata* var. *rugulata* (*M. rugulata*) and *Cythere retirugata* var. *textilis* (*M. retirugata*).

The last four ostracods are essentially Portland species, there is as yet no evidence that they occur in undoubted Purbeck strata.

Strahan (1898) stated that *Cypridea punctata* is the typical species of the Upper Purbeck, *C. granulosa* of the Middle Purbeck and *Cypris purbeckensis*, *Candona bononiensis* and *C. ansata* of the Lower Purbeck. This summary is incontrovertible and is the basis on which all subsequent subdivisions were based. Arkell (1947) for example, gave:

Upper Purbeck—*Cypridea punctata* and *C. ventrosa.*
Middle Purbeck—*C. fasciculata* and *M. forbesii.*
Lower Purbeck—*Candona ansata* and *Cypris purbeckensis.*

In 1940 Anderson proposed the following zonal subdivisions:

Upper Purbeck—Zone of *Langtonia setina* (*Cypridea setina*) and Zone of *Cypridea punctata* (*C. propunctata*).
Middle Purbeck—Zone of *Cypridea fasciculata* and Zone of *Cypridea granulosa.*
Lower Purbeck—Zone of *Candona bononiensis* (*Fabanella boloniensis*).

In 1949 Sylvester-Bradley subdivided the Upper Purbeck as follows:

Upper Purbeck—Zone of *C. setina* and Zone of *C. setina rectidorsata.*

The zonal scheme proposed in the present account is based entirely on the distribution of species of *Cypridea* which provide a much greater variety of forms than those of other contemporary genera:

Upper Purbeck—Zone of *Cypridea setina.* Characteristic species: *Cypridea alta* s.l., *C. propunctata*, *C. setina* s.l., *C. ventrosa*, *C. tuberculata adjuncta*, *C. wolburgi*, *C. acuta*, *C. brightlingensis*, *C. lata latissima*, *C. penshurstensis.*

Middle Purbeck—Zone of *Cypridea vidrana.* Characteristic species: *C. vidrana*, *C. darvelensis*, *C. tuberculata langtonensis*, *C. lata senilis;*

Zone of *Cypridea granulosa fasciculata.* Characteristic species: *C. granulosa fasciculata*, *C. coelnothi*, *C. delicatula*, *C. tumescens tumescens*, *C. posticalis*, *C. lata lata*, *C. swanagensis;*

Zone of *C. granulosa granulosa.* Characteristic species: *C. granulosa granulosa*, *C. sagena*, *C. peltoides eurygaster*, *C. granulosa protogranulosa*, *C. tumescens praecursor*, *C. dunkeri dunkeri.*

Lower Purbeck—Zone of *Cypridea dunkeri.* Characteristic species: *C. dunkeri papulata*, *C. dunkeri inversa*, *C. dunkeri carinata*, *C. tumescens acrobeles*, *C. peltoides peltoides*, *C. primaeva.*

FAUNICYCLES

In the Purbeck as in the Wealden (Anderson and others 1967) the ostracod assemblages are of two kinds, those in which species of the genus *Cypridea* predominate (C-phase faunas) and those in which the majority of individuals belong to genera other than *Cypridea* (S-phase species). Anderson (op. cit.) claimed that the C-phase assemblages represent conditions ranging from brackish to almost fresh water and that the S-phase assemblages are the consequence of more saline conditions, at times fully marine.

Whatever the ecological control may have been the fact is that throughout the Purbeck there is a constant alternation between two types of faunal assemblage, and furthermore these cycles, consisting of an S-phase below and a C-

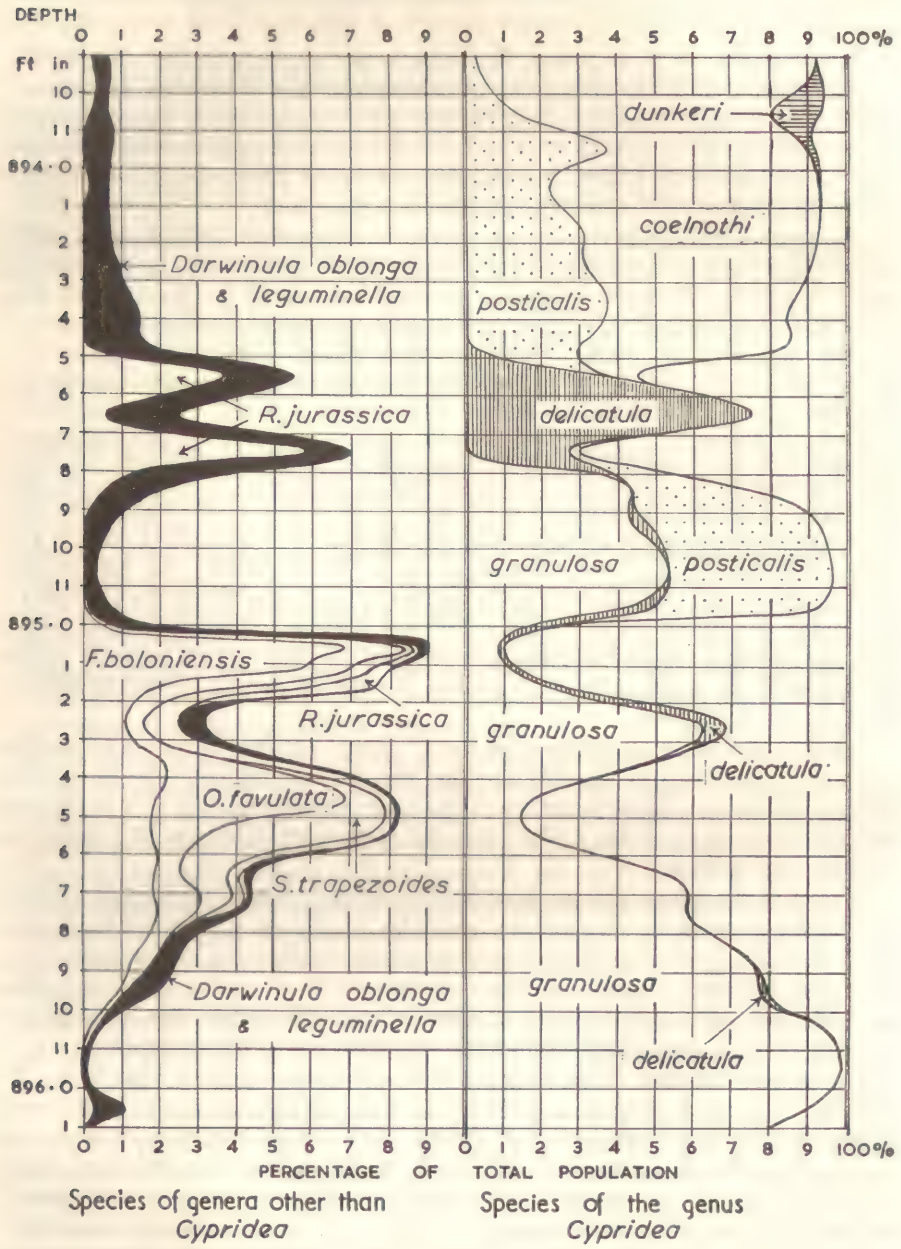


FIG. 6. *The Durlston faunicycle, Middle Purbeck*

phase above, appear to be traceable throughout the entire area of sedimentation. Thus a more refined subdivision of the Purbeck succession than that of the zones is possible and the correlation between basins of deposition can be made more exact.

Superimposed on these faunal fluctuations are changes in the composition of the faunas due to the emergence of new species and subspecies. In general, and this may be an indication of life in panmictic communities, a single species tends to dominate any particular faunal assemblage, sometimes for a considerable period. For example, in the *C. granulosa fasciculata* Zone, *C. granulosa fasciculata* is frequently the only C-phase species represented.

A complete faunicycle therefore consists of a phase of sedimentation when more saline conditions obtained (the S-phase) followed by a less saline phase in which species of the genus *Cypridea* dominate the fauna (C-phase). This is a truly cyclic phenomenon in that the change from one phase to the other is a gradual one, not always related to the sedimentary cycles described by Dr. Bazley above (pp. 23–5). In this the Purbeck cycles differ from those of the Coal Measures.

The succession of assemblages in the Goldspur Cycle of the Netherfield Place No. 5 Borehole (see Fig. 7) shows clearly that to regard each cycle as composed of a lower S-phase succeeded by an upper C-phase is to over simplify. In this particular case the cycle consists of three S-phases of which the lowest is the most marked, separated by C-phase faunas. Nevertheless, the generalized picture appears to be that each cycle represents a change from more saline to less saline conditions even though minor oscillations complicate the process. It is not without significance that the ostracods in the highest S-phase of the Goldspur Cycle are mainly Darwinulids, i.e. species which appear to have a wide salinity tolerance.

The emergence of new forms was not always sufficiently rapid to enable particular cycles to be identified thereby, but it is sometimes possible to distinguish two assemblages made up of the same species because of a change in the percentage composition of the fauna due to the varying degree of dominance of individual species.

Though imperfections in the record have made it impossible to find a complete sequence of cycles in any one borehole, a sufficient number of boreholes and sections has now been examined to make possible the compilation of a reasonably complete sequence. For convenience of reference the faunicycles have been named and not numbered since it is almost certain that future work will demand the interpolation of additional cycles not as yet recognized.

The analyses of four faunicycles are illustrated graphically in Figs. 6 and 7. The Durlston Cycle (Fig. 6) is probably the most complete example and forms a pattern with which others less complete can be compared. Sampling was at one-inch intervals through a total thickness of 2 ft 4 in. The percentage distribution of the ostracod species is recorded in two columns, the C-phase species on the right and the S-phase species on the left. The interpretation of this diagram is as follows: increase in salinity is first indicated by the appearance of Darwinulids followed by *Fabanella boloniensis*, *Orthonotacythere favulata* and *Scabriculocypris trapezoides* which constitute the fauna of the first S-phase at 895 ft 5 in. In this, but not in every case, the optimum of the S-phase is closely followed by a hypersaline (evaporite) phase in which *F. boloniensis* is the domi-

nant species. The first C-phase follows with *Cypridea granulosa* and *C. posticalis* after which comes a second S-phase at 894 ft 8 inches in which *Rhinocypris jurassica* and Darwinulids dominate the fauna. A second and main C-phase appears above 894 ft 5 in with *C. posticalis* and *C. coelnothi* as the dominant species.

This splitting of the S-phase into two or more sub-phases is common and in general the second appears to have represented less saline conditions than the first. Except in the Lower Purbeck the evaporite phase which follows the first S-phase is less usual. More often *F. boloniensis* is found as one, sometimes the main, constituent of the S-phase assemblage, as in the Burwash Cycle in Guestling No. 1 Borehole (Fig. 7).

Probably all species of *Cypridea* favoured a brackish-water environment, but it seems likely that this includes a wide range of salinities. In the Durlston Cycle, for example, the distribution of *Cypridea* species in the cycle suggests that *C. delicatula* could tolerate a greater degree of salinity than *C. granulosa*, *C. posticalis* less, *C. coelnothi* less still, whilst *C. dunkeri* possibly lived in almost fresh water. The S-phase species also probably had a wide range of salinity tolerance, from *F. boloniensis* and *F. ansata* commonly associated with evaporite deposits, through species of *Galliaecytheridea*, *Macrodentina* and *Orthonotacythere*, genera known to have lived in a marine environment, to species of *Rhinocypris*, *Theriosynoecum* and *Bisulcocypris* which may have been primarily brackish-water forms. Analysis of many cycles suggests that the Darwinulids were at their most abundant just preceding and just succeeding the full development of an S-phase, and were ostracods which thrived best in a salinity range intermediate between that of the S- and C-phase species. It has been claimed (Bate 1965) that *Rhinocypris*, *Theriosynoecum* and *Bisulcocypris*, by analogy with the living genera *Ilyocypris* and *Metacypris*, were fresh-water forms but their position in the faunicycle does not support this contention, and it does not follow that a genus now living in fresh water did so in the Mesozoic.

The sequence that led to the distribution of ostracods in a faunicycle is thought to be as follows. A long sequence of years of low rainfall reduced the flow of fresh water into the Purbeck lagoon so causing an increase in salinity (S-phase). In the Lower Purbeck particularly, this often continued to a state of almost complete aridity and the formation of evaporite deposits (E-phase). A reversal of this climatic trend resulted in the increase of fresh-water pressure and the lagoon freshened (C-phase). An immediate result of the increased rainfall was the development of vegetation probably as a fringe to the lagoon, in consequence of which much of the ground water available was absorbed and the fresh-water pressure in the lagoon again reduced with a consequent increase in salinity (second S-phase). Once the vegetation had reached its maximum development any further increase in rainfall would result in further freshening of the water in the lagoon leading to the establishment of the major C-phase. During the maximum rainfall period the lagoon may have been virtually a fresh-water lake into which the rejuvenated rivers brought coarser sediment. In this stage, not reached in every cycle, vegetation spread far into the lagoon and plant remains are common, often in the position of growth. Ostracods are generally absent, in fact ostracods of undoubted fresh-water affinities, such as species belonging to the Candonidae or Cypridae, have not been recorded from Purbeck or Wealden sediments. Those specimens referred to the genera *Candona* and *Cypris* by earlier workers have since been shown to belong to other genera.

A. The MOUNTFIELD Faunicycle,
Guestling No.1 B.H., Sussex.
B. The GOLDSPUR Faunicycle,
Guestling No.3 B.H., Sussex.
C. The BURWASH Faunicycle,
Guestling No.1 B.H., Sussex.

Continuous sampling.
'S' indicates a saline phase.

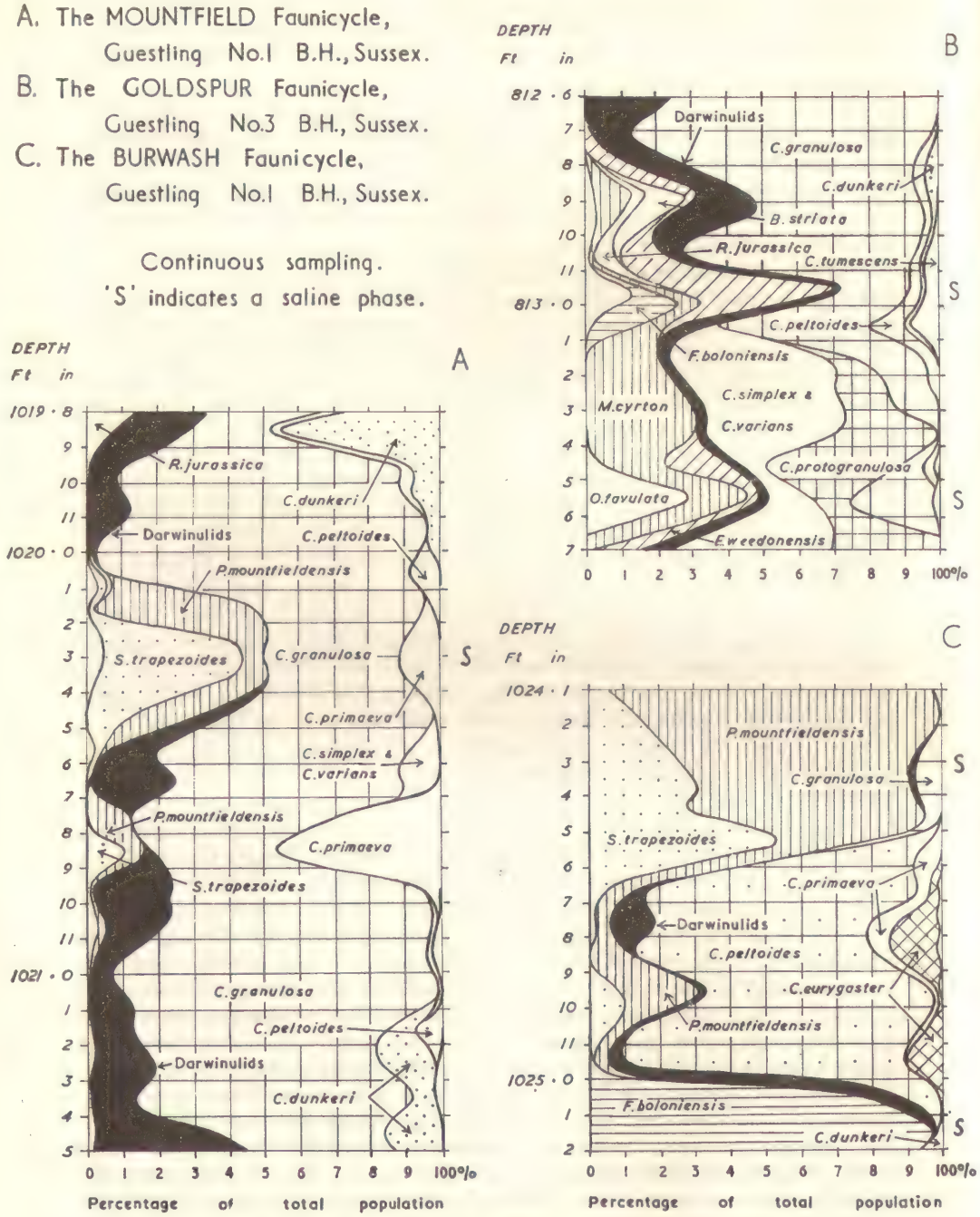


FIG. 7. *Three Purbeck faunicycles, the Mountfield, Goldspur and Burwash*

A possible cause of these recurrent cycles, if they are indeed climatic, is the precession of the equinoxes which by causing fluctuations in the caloric equator is believed to be responsible for the arid and non-arid cycles detected in the Sahara Desert (Zeuner 1958, p. 268). The periodicity of this cycle is 21 000 years. So far, 39 cycles have been detected in the Purbeck which would give this formation a duration of approximately 800 000 years. If the average sedimentation rate for the Jurassic is taken as 1136 years per foot (Holmes 1944), then the duration of the Purbeck should have been about 700 000 years (maximum thickness known, 620 ft in the Ashdown Borehole). The high proportion of limestones and shales in the Purbeck suggests that the sedimentation rate may well have been below the average for the Jurassic, i.e. nearer 1300 years per foot. These figures are sufficiently close to make the precession of the equinoxes a possible cause of the cycles.

The change from Portland to Purbeck conditions of deposition was determined by a slight regional uplift. The earliest evidence of this lies in the character of the marginal deposits. In the Portland Stone at Swindon in Wiltshire and in the area around Aylesbury in Buckinghamshire two cycles can be detected, the C-phases of which contain species of *Cypridea*, e.g. *C. dunkeri* and *C. tumescens*, which are characteristic forms in the succeeding Lower Purbeck deposits (Sylvester-Bradley 1941a, 1941b; Barker 1966b). The S-phase species of these cycles are predominantly Portland forms which are not found in the Purbeck Beds, but with some specimens of *F. boloniensis* in both cycles and *Mantelliana purbeckensis*, *Fabanella ansata*, *Scabriculocypris trapezoides* and *Klieana alata* also in the upper cycle, all of which continue into the Lower Purbeck.

In the Dorset area, farther from land but still very shallow water, the change from Portland to Purbeck deposition is marked by 'Dirt Beds' and tufas which probably represent the C-phase of the highest Portland cycle. In the basin of the Weald these oscillations between Portland and Purbeck type sedimentation have not been detected and the S-phase of the lowest Purbeck cycle appears to rest directly on a marine Portland limestone.

The Ostracod Faunas

BOREHOLES

Lower Purbeck, *Cypridea dunkeri* Zone.

Warren Cycle. Except in marginal areas such as Wiltshire and Buckinghamshire the transition from Portland to Purbeck is abrupt. In Dorset the Portland Stone is overlain by a bituminous sandy limestone with *Fabanella boloniensis* usually separated by a dirt bed. In the Weald, a grey limestone of Purbeck type rests with a sharp junction on a greyish green silty limestone with trigoniids and ammonites.

At Swindon in Wiltshire and in the area around Aylesbury, Buckinghamshire, Portland and Purbeck type sediments interdigitate over a thickness of up to 30 ft. In these transition beds two, possibly three, cycles appear to be represented of which the S-phase faunas consist of a mixture of Portland species such as *Macrodentina retirugata* and Purbeck species such as *Fabanella boloniensis*. The C-phase faunas include such typical Purbeck species as *Cypridea dunkeri papulata* and *C. tumescens acrobeles*.

Since brackish-water conditions are likely to have been established earlier in marginal areas than in the centre it is assumed that the transition beds are the homotaxial equivalent of the uppermost Portland Beds of the main sedimentary basins and that they represent earlier cycles than that (the Warren Cycle) here taken to be the base of the Purbeck.

The ostracod fauna of the Warren Cycle is limited, in the S-phase *Fabanella boloniensis*, *F. ansata*, *Mantelliana purbeckensis* and *Theriosynoecum forbesii*, in the C-phase *Cypridea dunkeri papulata* and *C. tumescens acrobeles*. In the Weald only the first three of these S-phase species have been found, in the Penshurst (1899) Borehole between 1105 and 1114 ft and the Henfield No. 1 Borehole between 1440 and 1445 ft, and the only evidence for a C-phase is the abundance of plant debris in the upper part of the cycle in the Warlingham Borehole.

Ridgeway Cycle. In this cycle *Damonella ellipsoidea* and *D. pygmaea* appear in the S-phase fauna. *F. boloniensis* is again the dominant species. As in the previous cycle, localities in the Weald have yielded little evidence. *M. purbeckensis* and *F. boloniensis* were found in the Warlingham Borehole between 2140 and 2144 ft 6 in. These two species together with *F. ansata*, *Damonella ellipsoidea*, *D. pygmaea*, *Scabriculocypris trapezoides* and *T. forbesii* occurred in the Henfield No. 1 Borehole between 1430 and 1440 ft. The only C-phase species found was *C. tumescens acrobeles* at Henfield.

Stair Cycle. This cycle also yields little ostracod evidence in the Weald and shows no change in the ostracod fauna. An S-phase fauna consisting of *F. ansata*, *F. boloniensis*, *D. ellipsoidea* and *S. trapezoides* was found in the Henfield No. 1 Borehole between 1409 and 1430 ft. So far a C-phase fauna has only been seen in Dorset, at Portisham.

Swindon Cycle. Again no change in the faunal assemblage was found. *F. boloniensis* still dominated the S-phase fauna. The only C-phase species recovered was *C. tumescens acrobeles*. In the Weald this cycle has only been recognized in the Henfield No. 1 Borehole between 1386 and 1409 ft, and in the Goldspur Drift between 190 and 213 ft.

Upwey Cycle. In the S-phase of this cycle two species appear for the first time, namely *Damonella buchaniana*, which continued as a common form throughout the Purbeck Beds, and *Wolburgia polyphema* Anderson, 1966 (not redescribed here), a rare form only seen in this and the succeeding cycle. In the C-phase faunas *Cypridea dunkeri* is represented by the subspecies *inversa* and is accompanied by *C. tumescens acrobeles*.

In the Weald this cycle was recognized in the Warlingham Borehole between 2100 ft 2 in and 2107 ft 11 in (S-phase only), Mountfield No. 4 Borehole between 446 ft 6 in and 458 ft 6 in (C-phase only), Brightling No. 27 Borehole between 883 ft and 895 ft 6 in, Penshurst (1899) Borehole between 1022 ft and 1042 ft 6 in (S-phase only) and Penshurst (1938) Borehole between 907 ft and 927 ft 6 in (S-phase only).

Hard Cockle Cycle. This cycle yielded the most abundant and varied ostracod fauna in the *C. dunkeri* Zone. The S-phase as before was dominated by *Fabanella boloniensis* and *Mantelliana purbeckensis* was common. Other species present were *W. polyphema*, *Damonella buchaniana*, *D. pygmaea*, *D. ellipsoidea*, *Darwinula leguminella*, *D. oblonga*, *Rhinocypris jurassica*, *Klieana dictyota*, *S. trapezoides* and the new arrivals *Mantelliana* cf. *wealdensis*, *M. cyrton* and *Bisulcocypris striata*.

The C-phase species found were *Cypridea dunkeri inversa*, *C. tumescens acrobeles* (the dominant form) and *C. primaeva* together with two new arrivals, *C. peltoides peltoides* and *C. granulosa protogranulosa*. *C. peltoides* is an important, often abundant species in the lower half of the Purbeck Beds and is probably recorded as *Cypridea punctata* in some of the older published accounts.

In the Weald this cycle was found in the Warlingham Borehole between 2080 ft 1 in and 2100 ft 2 in (S-phase only), Mountfield No. 4 Borehole between 414 ft 6 in and 446 ft 6 in, Netherfield Place No. 3 Borehole between 1052 ft and 1082 ft 6 in (S-phase only), Netherfield Place No. 5 Borehole between 1012 ft and 1042 ft 6 in, Guestling No. 3 Borehole between 877 ft 6 in and 898 ft, Penshurst (1938) Borehole between 877 and 907 ft (S-phase only), Henfield No. 1 Borehole between 1352 and 1377 ft and the Goldspur Drift between 145 and 177 ft.

Wardour Cycle. The S-phase fauna of this cycle showed no change and in the C-phase also no new forms were added. Generally, however, the specimens of *C. dunkeri inversa* were more strongly tuberculate than in the cycle below.

A fauna from both phases of this cycle was collected from the Warlingham Borehole between 2073 ft and 2080 ft 1 in, Mountfield No. 4 Borehole between 403 ft 6 in and 414 ft 6 in, Netherfield Place No. 3 Borehole between 1040 ft 6 in and 1052 ft, Guestling No. 3 Borehole between 872 ft and 877 ft 6 in and the Goldspur Drift between 133 and 145 ft.

Lower Soft Cockle Cycle. The fauna of this cycle was as before with *F. boloniensis* as the dominant species in the S-phase but enriched by the appearance of three additional species, *Orthonotacythere favulata*, *Pseudoparacypridopsis mountfieldensis* and *Timiriasevia* cf. *mackerrowi*. In the C-phase the examples of *C. dunkeri inversa* were again strongly ornamented though the tubercles were usually fewer in number than in the previous cycle.

In the Weald the Lower Soft Cockle Cycle was recognized in the Warlingham Borehole between 2051 and 2073 ft, Mountfield No. 4 Borehole between 376 ft 6 in and 403 ft 6 in. Netherfield Place No. 3 Borehole between 1009 ft and 1040 ft 6 in, Guestling No. 3 Borehole between 847 and 872 ft (S-phase only), Brightling No. 27 Borehole between 811 and 841 ft, Ashdown No. 1 Borehole between 913 and 958 ft and the Henfield No. 1 Borehole between 1319 ft and 1343 ft 6 in.

Upper Soft Cockle Cycle. The S-phase fauna was as before and still dominated by *F. boloniensis*. In the C-phase a few examples of *C. peltoides* showed the swollen venter characteristic of the subspecies *eurygaster* and the first examples of *C. simplex*, a common species in the Upper Purbeck, were seen.

This cycle was found in the following boreholes and sections: the Warlingham Borehole between 2040 ft 9 in and 2051 ft (S-phase only), Mountfield No. 4 Borehole between 361 ft and 376 ft 6 in, Netherfield Place No. 3 Borehole between 992 ft 6 in and 1009 ft (C-phase only), Netherfield Place No. 5 Borehole between 952 ft 6 in and 969 ft (C-phase only), Guestling No. 3 Borehole between 833 and 847 ft and the Goldspur Drift between 88 ft and 104 ft 6 in.

Penshurst Cycle. In the S-phase of this cycle the only common species was *F. boloniensis*, but *M. purbeckensis* also occurred at Warlingham and *M. cyrton* at Brightling. In the Warlingham Borehole a few ostracods were found which appear to be early examples of *Galiaecytheridea postsinuata* Wolburg, a form

characteristic of the Cinder Beds. The only change in the C-phase fauna was that *C. peltoides* showed signs of genetic instability. Some individuals were swollen ventrally and bore a number of small tubercles. This form is named as the subspecies *C. peltoides eurygaster*.

The Penshurst Cycle was recognized in only three of the boreholes in the Weald, viz. Warlingham between 2037 ft 8 in and 2040 ft 9 in (S-phase only), Guestling No. 3 between 829 and 833 ft (C-phase only), and Brightling No. 27 between 787 ft 6 in and 793 ft 6 in.

Ringstead Cycle. There were no new additions to the S-phase fauna which was still dominated by *F. boloniensis*, but in the C-phase *C. dunkeri* showed signs of change. Though the tubercles were strong and abundant as before, the outline of the carapace was more triangular as in the subspecies *C. dunkeri carinata*.

In the Weald the Ringstead Cycle was seen in the Warlingham Borehole between ?2034 ft and 2037 ft 8 in, Mountfield No. 4 Borehole between 351 ft 6 in and 355 ft 6 in, Netherfield Place No. 3 Borehole between 983 ft and 987 ft 6 in (S-phase only) and Guestling No. 3 Borehole between 825 and 829 ft.

Robertsbridge Cycle. In the S-phase of this cycle the ostracod assemblages were as before with *F. boloniensis* as the commonest species, but with the addition of *Bisulcocypris dilatata*. In the C-phase *C. tumescens acrobeles* was replaced by *C. tumescens praecursor*.

The Robertsbridge Cycle was identified in the Mountfield No. 4 Borehole between 346 ft 6 in and 351 ft 6 in, Guestling No. 1 Borehole between 1027 ft 6 in and 1030 ft, Guestling No. 3 Borehole between 822 ft 6 in and 825 ft (S-phase only), Penshurst (1899) Borehole between 900 and 905 ft, and the Goldspur Drift between 73 ft 6 in and 78 ft 5 in.

Burwash Cycle. The S-phase species in this cycle consisted of *B. striata*, *Damonella ellipsoidea*, *D. pygmaea*, *Darwinula leguminella*, *D. oblonga*, *Eoparacypris weedonensis*, *M. purbeckensis*, *Pseudoparacypridopsis mountfieldensis* and *F. boloniensis* as the dominant form. In the C-phase *C. tumescens praecursor*, *C. dunkeri carinata*, *C. peltoides peltoides* and *C. granulosa protogranulosa* were the characteristic species.

This cycle is better seen in the Weald than in the Hampshire–Dorset basin. It was recognized in the Warlingham Borehole between 2028 ft 6 in and 2031 ft 6 in, Mountfield No. 4 Borehole between 342 ft 9 in and 346 ft 6 in, Guestling No. 1 Borehole between 1024 ft 6 in and 1027 ft 6 in, Guestling No. 3 Borehole between 819 ft 6 in and 822 ft 6 in, Henfield No. 1 Borehole between 1290 ft and 1293 ft 6 in and the Goldspur Drift between 69 ft 6 in and 73 ft 6 in. Both C- and S-phases were indicated in all but the Warlingham Borehole and the S-phases were particularly rich in Guestling No. 3 and Henfield No. 1 boreholes.

Mountfield Cycle. This is the highest cycle in the Lower Purbeck (*C. dunkeri* Zone). In the S-phase assemblages eighteen species were represented amongst which *F. boloniensis*, *S. trapezoides*, *T. forbesii*, *E. weedonensis*, *Damonella pygmaea* and Darwinulidae were the most abundant. *Klieana thoracina* occurred for the first time. Specimens doubtfully attributed to the rare species *Scabriculocypris acanthoides* were seen but the typical Lower Purbeck species *Fabanella ansata* was no longer present. In the C-phase the assemblage was as before with the addition of the earliest examples of *C. granulosa granulosa*, *C. sagena* and *C. varians varians*.

This cycle was recognized in nine of the Weald boreholes and sections, i.e. Warlingham Borehole between 2027 ft 3 in and 2028 ft 6 in, Mountfield No. 4 Borehole between 334 ft 6 in and 342 ft 9 in, Netherfield Place No. 5 Borehole between 925 and 934 ft, Guestling No. 1 Borehole between 1019 ft and 1024 ft 6 in, Guestling No. 3 Borehole between 814 ft and 819 ft 6 in, Brightling No. 27 Borehole between 764 ft 6 in and 775 ft, Ashdown No. 1 Borehole between 855 and 866 ft, Henfield No. 1 Borehole between 1285 and 1290 ft (C-phase only) and the Goldspur Drift between 60 ft and 69 ft 6 in.

MIDDLE PURBECK, *Cypridea granulosa granulosa* Zone.

Goldspur Cycle. No significant faunal change marks the base of the Middle Purbeck. In the S-phase faunas *S. trapezoides*, *T. forbesii*, *M.* cf. *wealdensis*, *F. boloniensis* and *B. striata* are the common species. *Scabriculocypris cerastes* and *K. dictyota* are rare.

This cycle is well represented both in the Weald and in the Hampshire–Dorset basin. It was seen in the Warlingham Borehole between 2015 ft 10 in and 2026 ft, Mountfield No. 4 Borehole between 323 ft 3 in and 334 ft 6 in, Netherfield Place No. 5 Borehole between 913 ft 3 in and 925 ft, Guestling No. 1 Borehole between 1010 and 1019 ft (S-phase only), Guestling No. 3 Borehole between 805 and 814 ft, Brightling No. 27 Borehole between 753 ft 3 in and 764 ft 6 in, Ashdown No. 1 Borehole between 840 and 855 ft, Penshurst (1899) Borehole between 870 and 885 ft, Henfield No. 1 Borehole between 1274 and 1285 ft and the Goldspur Drift between 49 and 60 ft (C-phase only).

Ashdown Cycle. The S-phase fauna of this cycle showed no change and in the C-phase the only new arrivals were *C. coelnothi*, a species never very common except in the Durlston Cycle above, and the inverse species *C. delicatula*. *C. granulosa granulosa* was the dominant form.

The Ashdown Cycle was identified in the Weald in the Warlingham Borehole between 2013 ft and 2015 ft 10 in, Mountfield No. 4 Borehole between 319 ft and 323 ft 3 in, Netherfield Place No. 5 Borehole between 909 ft and 913 ft 3 in, Brightling No. 27 Borehole between 749 ft and 753 ft 3 in, Ashdown No. 1 Borehole between 835 and 840 ft, Penshurst (1899) Borehole between 866 and 870 ft and the Goldspur Drift between 44 ft 6 in and 49 ft (C-phase only).

Swanage Cycle. The S-phase assemblages in this cycle remained as before but in the C-phase *C. dunkeri dunkeri* replaced *C. dunkeri carinata*, and *C. peltoides eurygaster* was absent. *C. granulosa granulosa* was the dominant species.

In the Weald this cycle was seen in the Warlingham Borehole between 2010 and 2013 ft, Mountfield No. 4 Borehole between 313 ft 6 in and 319 ft, Netherfield Place No. 5 Borehole between 903 ft 6 in and 909 ft and the Goldspur Drift between 39 ft and 44 ft 6 in. The fauna was particularly rich in the Netherfield Place No. 5 Borehole.

Netherfield Cycle. There was still no significant change in the composition of the S-phase fauna of this cycle but the C-phase assemblages, although still dominated by *C. granulosa granulosa*, included three new arrivals, viz. *C. lata lata*, *C. swanagensis swanagensis* and, near the top of the cycle, *C. posticalis*.

In the Weald this cycle was seen in the Warlingham Borehole between 2004 ft 10 in and 2010 ft, Mountfield No. 4 Borehole between 305 ft 9 in and 313 ft

6 in, Netherfield Place No. 5 Borehole between 895 ft 9 in and 903 ft 6 in and in the Goldspur Drift between 31 ft 3 in and 39 ft.

Cypridea granulosa fasciculata Zone.

Durlston Cycle. This cycle contained a rich and varied fauna. In the S-phases the assemblages were little changed except for the addition of *Eoparacypris attenuata*. The commonest forms were *B. striata*, *R. jurassica* and Darwinulids. In the C-phase fauna *C. dunkeri* with a much reduced ornament, *C. tumescens tumescens*, *C. coelnothi*, *C. lata lata* and *C. granulosa granulosa* were fairly common but *C. granulosa fasciculata*, here seen for the first time, is the dominant species. Confined to this cycle is the subspecies *C. swanagensis ornata*. The most important species, however, is *C. posticalis* which, apart from sporadic occurrences at the top of the cycle below, is confined to the Durlston Cycle and has been found at this horizon throughout southern England.

The Durlston Cycle has been recognized at the following localities in the Weald: the Warlingham Borehole between 1997 ft 6 in and 2004 ft 10 in, Mountfield No. 3 Borehole between 362 ft 6 in and 371 ft 3 in (C-phase only), Mountfield No. 4 Borehole between 297 ft and 305 ft 9 in (C-phase only), Netherfield Place No. 5 Borehole between 887 ft and 895 ft 9 in, Penshurst (1899) Borehole between 838 and 849 ft, Henfield No. 1 Borehole between 1251 and 1259 ft, the Goldspur Drift between 22 ft 6 in and 31 ft 3 in, and the Milkhurst Wood and Nine Acre Wood sections.

Peveril Cycle. In the S-phase of this cycle two species appeared which are especially characteristic of the overlying Cinder Beds, viz. *Procytheropteron brodiei* and *Orthonotacythere cineraria*. *B. dilatata* and *P. mountfieldensis* have not been seen above this level. In the C-phase *C. dunkeri dunkeri* made a last appearance and *C. coelnothi*, *C. swanagensis* and *C. posticalis* were no longer part of the assemblage.

In the Weald this cycle was found in the Warlingham Borehole between 1994 ft 1 in and 1997 ft 6 in, Mountfield No. 3 Borehole between 355 ft 6 in and 362 ft 6 in, Mountfield No. 4 Borehole between 290 ft and 297 ft (S-phase only), Penshurst (1899) Borehole between 830 and 838 ft, in the Goldspur Drift between 15 ft 6 in and 22 ft 6 in, and in the Nine Acre Wood section.

Cinder Beds Cycle. The S-phase of this cycle (Cinder Beds) is the best known saline phase in the Purbeck. The dominant species is *Galliaecytheridea postsinuata* accompanied by most of the S-phase species known in the Purbeck, viz. *B. striata*, *Damonella ellipsoidea*, *D. pygmaea*, *E. attenuata*, *E. weedonensis*, *F. boloniensis*, *K. alata*, *K. dictyota*, *Mantelliana purbeckensis*, *M.* cf. *wealdensis*, *Procytheropteron brodiei*, *Stenestroemia fragilis*, *T.* cf. *mackerrowi*, with *Stillina arkelli* sp. nov., known only from the Cinder Beds, and *S. durlstonensis* the largest species of *Scabriculocypris* so far known.

The C-phase of this cycle is poorly developed but where seen *C. granulosa fasciculata* is usually the dominant species.

In the Weald, though *Liostrea distorta* is common in the Cinder Beds S-phase, it is disseminated and does not form a shell bank as in Dorset, but the ostracod fauna is distinctive and the horizon is easily identified. This cycle was identified in the Warlingham Borehole between ?1987 ft 10 in and 1994 ft 1 in, Ashdown No. 1 Borehole between 781 ft and 796 ft 7 in (S-phase only), the Goldspur

Drift between 2 ft 6 in and 15 ft 6 in (S-phase only) and in the sections at Milkhurst Wood and Nine Acre Wood.

Nothe Cycle. In the S-phase of this and later cycles *F. boloniensis* is no longer an important member of the ostracod fauna and other species characteristic of the strata below the Cinder Beds have either gone or make a last appearance in the Nothe Cycle, viz. *B. dilatata*, *K. alata*, *M. purbeckensis* and *S. trapezoides*. *B. striata* is the dominant form accompanied by *Damonella buchaniana*, *D. ellipsoidea*, *D. pygmaea* and Darwinulids.

The C-phase of this cycle also marks the end of several of the species characteristic of the lower half of the Purbeck such as *C. primaeva*, *C. peltoides*, *C. granulosa granulosa*, *C. granulosa protogranulosa*, and the incoming of a new form, *Cypridea amisia*.

In the Weald this cycle was seen in the Warlingham Borehole between ?1986 ft and ?1987 ft 10 in, Mountfield No. 3 Borehole between 335 ft and 342 ft 6 in, Mountfield No. 4 Borehole between 269 ft 6 in and 277 ft, Ashdown No. 1 Borehole between 771 and 781 ft, in the Goldspur Drift between 0 and 2 ft 6 in (part only) and in the Milkhurst Wood section.

Croydon Cycle. The fauna of the S-phase in this cycle was relatively poor due to the disappearance in this and the previous cycle of many of the forms found at lower horizons not yet replaced by newly arrived species. The most abundant ostracods were *B. striata*, *Damonella buchaniana* and Darwinulids. In the C-phase also the fauna is limited. The only common species was *C. granulosa fasciculata* but there was one new arrival, *C. altissima* Martin, which occurred doubtfully in the Chilcomb Down Borehole in Hampshire but which has not yet been found at this horizon in the Weald.

The Croydon Cycle was seen in the Weald in the Warlingham Borehole between ?1981 and ?1986 ft (S-phase only), Mountfield No. 3 Borehole between 329 and 335 ft (S-phase only), Mountfield No. 4 Borehole between 263 ft 6 in and 269 ft 6 in (S-phase only) and in the Milkhurst Wood section (complete).

Royal Cycle. The S-phase of this cycle was everywhere poorly developed with sparse faunas consisting mainly of *B. striata* and *Orthonotacythere nodosaria* sometimes accompanied by *F. boloniensis*, *Damonella pygmaea* and *Stenestroemia fragilis*. In the C-phase several of the typical upper Middle and Upper Purbeck species were now established, viz. *C. altissima*, *C. lata senilis*, *C. amisia* and *C.* cf. *inaequalis*, but the faunas were sparse.

This cycle was recognized in the Weald in the Mountfield No. 3 Borehole between 324 and 329 ft, Ashdown No. 1 Borehole between 748 and 758 ft (C-phase only) and the Penshurst (1899) Borehole between 785 ft and 793 ft 6 in.

Corfe Cycle. The S-phase fauna in the Weald remained as before but in the Hampshire–Dorset basin there was an important new arrival, *Macrodentina mediostricta*, a characteristic species of the upper part of the Middle Purbeck. The C-phase faunas were augmented by the arrival of *Cypridea acuta* but otherwise remained as before.

In the Weald this cycle was seen in the Mountfield No. 3 Borehole between 310 and 324 ft, Mountfield No. 4 Borehole between 244 ft 6 in and 258 ft 6 in (C-phase only), Guestling No. 3 Borehole between 741 ft 6 in and 750 ft, Brightling No. 27 Borehole between 675 and 689 ft (C-phase only), Penshurst

(1899) Borehole between 769 and 785 ft (S-phase only) and Penshurst (1938) Borehole between 654 and 670 ft (C-phase only).

Worth Cycle. Again the S-phase faunas were sparse. *B. striata* was still the commonest species. The rare form *Klieana thoracina* sp. nov. was seen in the Mountfield No. 3 Borehole. *M. mediostricta* was seen for the first time in the Weald. *C. granulosa fasciculata* was still present in the C-phase faunas but was superseded by *C. amisia* as the dominant form. *C. brevirostrata*, a common species in the lowest beds of the Wealden, was seen for the first time in this cycle.

The Worth Cycle was recognized in the Weald in the Mountfield No. 3 Borehole between 302 ft 6 in and 310 ft, Brightling No. 27 Borehole between 667 and 675 ft, Penshurst (1899) Borehole between 760 and 769 ft, Penshurst (1938) Borehole between 645 and 654 ft (C-phase only) and Henfield No. 1 Borehole between 1200 and 1207 ft.

Langton Cycle. The S-phase fauna of this cycle was limited, consisting only of *M. mediostricta*, *O. nodosaria* and Darwinulids. In the C-phase, though *C. amisia* was still the dominant species, there were two important new arrivals, *C. vidrana* Wolburg and *C. penshurstensis* sp. nov. *C. granulosa fasciculata* has not been identified with certainty above this horizon.

The cycle was seen in the Weald in the Mountfield No. 3 Borehole between 296 ft and 302 ft 6 in, Mountfield No. 4 Borehole between 230 ft 6 in and 237 ft (C-phase only), Guestling No. 1 Borehole between 935 and 941 ft, Penshurst (1899) Borehole between 748 and 760 ft, Penshurst (1938) Borehole between 633 and 645 ft and in the Milkhurst Wood section (C-phase only).

Cypridea vidrana Zone.

Scallop Cycle. This cycle includes the limestone known in Dorset as the Scallop Bed but in the Weald the horizon is not lithologically distinguishable. Faunally the S-phase showed no significant change, the only new addition is the arrival of *Darwinula jonesi* sp. nov., essentially a Wealden species and only rarely seen in the Purbeck. There were three important additions to the C-phase faunas, *C. andersoni*, *C.* cf. *martini* and *C. bimammata*. Forms which may represent early examples of *C. darvelensis* and others which may be late varieties of *C. granulosa fasciculata* with very much reduced ornament were found. *C. tuberculata langtonensis* appears to be confined to this cycle.

In the Weald the Scallop Cycle has been identified in the Warlingham Borehole between 1961 ft 6 in and 1967 ft 2 in, Mountfield No. 3 Borehole between 280 and 296 ft, Mountfield No. 4 Borehole between 214 ft 6 in and 230 ft 6 in (S-phase only), Guestling No. 1 Borehole between 924 and 935 ft (C-phase only), Brightling No. 27 Borehole between 643 and 660 ft (C-phase only), Ashdown No. 1 Borehole between 693 and 708 ft and in the Milkhurst Wood and Binglett's Wood sections.

Studland Cycle. In the S-phase of this cycle *M. mediostricta* was still present but *R. jurassica* was the more common species. *B. striata monotuberculata* was seen for the first time. *M.* cf. *wealdensis* was fairly common. In the C-phase another of the typical Upper Purbeck species appeared, i.e. *Cypridea dolabrata*. *C. vidrana*, *C. penshurstensis*, *C. altissima*, *C. lata senilis*, and *C. simplex* are species typical of this cycle.

The Studland Cycle was recognized in the Weald in the Warlingham Borehole between 1954 ft 3 in and 1961 ft 6 in, Mountfield No. 3 Borehole between 270 and 280 ft, Guestling No. 3 Borehole between 710 and 719 ft (C-phase only), Penshurst (1899) Borehole between 720 and 733 ft and in the Binglett's Wood section (S-phase only).

Bacon Cycle. The S-phase fauna of this cycle was very limited, *M. mediostricta*, *R. jurassica* and Darwinulids were the only common forms. The C-phase faunas, however, were augmented by an important new arrival, *C. setina rectidorsata*, a typical Upper Purbeck form.

In the Weald the cycle was seen in the Warlingham Borehole between 1949 ft 9 in and 1954 ft 3 in, Mountfield No. 3 Borehole between 255 and 270 ft, Mountfield No. 4 Borehole between 189 ft 6 in and 204 ft 6 in (C-phase only), Brightling No. 27 Borehole between 619 ft 6 in and 633 ft, Ashdown No. 1 Borehole between 665 and 679 ft, Guestling No. 1 Borehole between 903 and 915 ft (C-phase only), Penshurst (1899) Borehole between 708 and 720 ft, Henfield No. 1 Borehole between 1156 and 1167 ft and in the Binglett's Wood section.

Poxwell Cycle. The S-phase fauna of this cycle was primarily composed of *M. mediostricta* and *R. jurassica* with Darwinulids. In the C-phase, *C. lata latissima* was new but *C. inaequalis* (typical forms) and *C. amisia* were no longer present.

The cycle has been seen in the Warlingham Borehole between 1942 ft 11 in and 1949 ft 9 in, Mountfield No. 3 Borehole between 243 ft 6 in and 255 ft, Guestling No. 1 Borehole between 895 and 903 ft, Brightling No. 27 Borehole between 607 ft 6 in and 619 ft 6 in, Ashdown No. 1 Borehole between 650 and 665 ft (S-phase only), Henfield No. 1 Borehole between 1145 and 1156 ft and in the Binglett's Wood section (S-phase only).

Greenwood Cycle. *M. mediostricta* appeared for the last time in the S-phase of this cycle. In the C-phase *C. wolburgi* appears for the first time and *C. lata latissima*, which in the Weald was first encountered in the Poxwell Cycle, now appeared in the Hampshire–Dorset basin. *C. vidrana* made a last appearance and *C. altissima* had gone.

This cycle has been identified in the Weald in the Warlingham Borehole between ?1940 ft and 1942 ft 11 in, Mountfield No. 3 Borehole between 226 ft and 243 ft 6 in, Netherfield Place No. 3 Borehole between 786 and 805 ft, Penshurst (1899) Borehole between 667 and 694 ft and in the Henfield No. 1 Borehole between 1130 and 1145 ft.

UPPER PURBECK, *Cypridea setina* Zone.

Lulworth Cycle. As is usual in the Upper Purbeck the S-phase of this cycle yielded an impoverished fauna in which *R. jurassica* was the dominant species accompanied by *B. striata*, *M.* cf. *wealdensis* and Darwinulids. In the C-phase the fauna was dominated by *C. setina setina* and *C. setina rectidorsata* but most of the typical Upper Purbeck species were also present, viz. *C. alta formosa* (confined to the Upper Purbeck), *C. lata latissima*, *C. propunctata* (confined to the Upper Purbeck), *C. varians*, *C. wicheri* and *C. wolburgi*, a species which, except for a rare occurrence in the previous cycle, is only known from this and the succeeding Mupes Cycle.

The Lulworth Cycle was identified in the Weald in the Warlingham Borehole between 1929 ft 6 in and 1940 ft (C-phase only), Mountfield No. 3 Borehole between 216 and 226 ft (C-phase only), Netherfield Place No. 3 Borehole between 775 ft 6 in and 786 ft, Penshurst (1899) Borehole between 655 and 667 ft and in the Penshurst (1938) Borehole between 540 and 552 ft (C-phase only).

Mupes Cycle. The S-phase fauna of this cycle was similar to that of the previous cycle except for the occurrence of *T.* cf. *mackerrowi* at Warlingham and Mountfield. *O. nodosaria* has not been found above this level. In the C-phase *C. setina* was the dominant species largely represented by the subspecies *erumna* and *rectidorsata*. *C. propunctata*, *C. penshurstensis*, and *C. lata latissima* were common. *C. ventrosa* was a new arrival in this cycle in Dorset but the species has not yet been found in the Weald.

The Mupes Cycle has been recognized in the Weald in the Warlingham Borehole between 1924 ft 9 in and 1929 ft 6 in, Mountfield No. 3 Borehole between 209 and 216 ft and in the Henfield No. 1 Borehole between 1110 and 1119 ft.

Brede Cycle. The S-phase faunas of this cycle were further impoverished by the disappearance of *O. nodosaria* and *B. striata monotuberculata*. Generally only *R. jurassica*, *B. striata striata* and Darwinulids were common. In the C-phase faunas *C. setina setina* and *C. setina rectidorsata* are the dominant species. *C. lata latissima* has not been seen in higher cycles.

In the Weald this cycle was seen in the Warlingham Borehole between 1918 ft 3 in and 1924 ft 9 in, Mountfield No. 3 Borehole between 193 and 209 ft and in the Penshurst (1899) Borehole between 630 and 641 ft.

Tisbury Cycle. In this cycle the S-phase fauna showed no important change. In the C-phase *C. setina setina* and *C. setina erumna* were common and usually accompanied by *C. propunctata*, *C. penshurstensis* and *C. simplex*. The earliest example of *C. tuberculata adjuncta* was seen at Henfield.

In the Weald this cycle was recognized in the Warlingham Borehole between 1915 ft 2 in and 1918 ft 3 in, Mountfield No. 3 Borehole between 184 and 193 ft, Netherfield Place No. 5 Borehole between 743 and 752 ft, Penshurst (1899) Borehole between 620 and 630 ft and in the Henfield No. 1 Borehole between 1091 and 1101 ft (C-phase only).

Durdle Cycle. In this cycle the composition of the S-phase faunas was as before but in general the phase was poorly developed. In the C-phase *C. setina* (subspecies *setina*, *dotica* and *erumna*) dominated the fauna accompanied by *C. alta alta*, *C. alta formosa* and *C. penshurstensis*. *C. setina rectidorsata*, though present, was less common than before and *C. andersoni* made a last appearance.

In the Weald this cycle was only seen in two boreholes, Warlingham between 1908 ft 6 in and 1915 ft 2 in and Mountfield No. 3 between 165 and 184 ft (C-phase only).

Tyneham Cycle. The S-phase fauna was as before with *B. striata*, *R. jurassica* and Darwinulids as the commonest forms. The C-phase of this cycle contained the last of the typical Upper Purbeck ostracod assemblages. *C. setina* was still the dominant species represented by the subspecies *setina*, *dotica*, *erumna* and the characteristic *camelodes*. *C. varians* was accompanied by *C. acuta*, *C. alta alta*, *C. dolabrata*, *C. penshurstensis*, *C. tuberculata adjuncta* and *C. wicheri*.

In the Weald this cycle was identified in the Warlingham Borehole between ?1905 ft and 1908 ft 6 in, Netherfield Place No. 5 Borehole between 714 and 723 ft, Guestling No. 1 Borehole between 827 ft 6 in and 835 ft 6 in (C-phase only), Penshurst (1899) Borehole between 584 and 598 ft and in the Henfield No. 1 Borehole between 1065 ft and 1077 ft 6 in (C-phase only).

Battle Cycle. In this cycle the impoverished S-phase fauna showed no significant change but the C-phase assemblages were transitional to those found in the lowest Wealden strata. *C. setina* was still present but was less common. The subspecies usually found was *C. setina acerata*, the typical form of the lowest (Hastings) cycle of the Wealden. *C. morula* was seen for the first time in this cycle in the Hampshire basin but not in the Weald. *C. wicheri* was more abundant than before and like *C. morula* is a form characteristic of the basal Wealden beds. *C. alta formosa* was no longer present and *C. setina rectidorsata* and *C. propunctata* made their last appearance.

The Battle Cycle was identified in the Weald in the Warlingham Borehole between 1889 and ?1905 ft (C-phase only), Netherfield Place No. 5 Borehole between 678 and 714 ft, and in the Guestling No. 1 Borehole between 801 ft and 827 ft 6 in.

SECTIONS

The Goldspur Drift

The Drift (Howitt 1964, p. 84 and fig. 3) began at a horizon about 2 ft above the top of the Cinder Beds Cycle and continued downwards to the top of No. 1 Gypsum Seam at 205 ft 11 in. It thus penetrated the lower half of the Middle Purbeck and the greater part of the Lower Purbeck Beds.

Middle Purbeck

The highest beds seen, between 0 and 2 ft contained the C-phase fauna of the **Nothe Cycle,** i.e. *C. delicatula*, *C. granulosa fasciculata* and *C. simplex*. From 2 ft to 2 ft 6 in the ostracods were the S-phase species *G. postsinuata* and *K. dictyota*.

In the **Cinder Beds Cycle** (2 ft 6 in to 15 ft 6 in) the only ostracods found comprised a typical S-phase assemblage between 4 ft 6 in and 15 ft 6 in, viz. *G. postsinuata*, *K. dictyota* and *O. cineraria*.

The **Peveril Cycle** below extended from 15 ft 6 in to 22 ft 6 in. Here the C-phase fauna consisted of *C. granulosa fasciculata*, *C. granulosa protogranulosa*, *C. lata lata*, *C. primaeva* and *C. tumescens tumescens*, and the S-phase species were *S. trapezoides*, *P. mountfieldensis*, *F. boloniensis*, *Darwinula leguminella* and *E. weedonensis*.

In the **Durlston Cycle** (22 ft 6 in to 31 ft 3 in) the C-phase was well developed and from seven samples the following species were collected: *C. coelnothi*, *C. delicatula*, *C. granulosa granulosa*, *C. granulosa fasciculata*, *C. granulosa protogranulosa*, *C. lata lata*, *C. posticalis*, *C. simplex*, *C. swanagensis*, *C. tumescens tumescens* and *C. varians*. The S-phase species present were *Damonella ellipsoidea*, *Darwinula oblonga*, *D. leguminella* and *R. jurassica*. Such an assemblage is typical of this horizon in the Weald. *C. posticalis* in particular is especially characteristic of the Durlston Cycle though it is sometimes found less commonly in the cycle below.

The **Netherfield Cycle** seen between 31 ft 3 in and 39 ft yielded the following C-phase species: *C. delicatula*, *C. granulosa granulosa* (the dominant form), *C. granulosa protogranulosa*, *C. peltoides peltoides* and *C. simplex*, with *C. coelnothi* and *C. posticalis* in the top 1 ft 7 in of the cycle. The S-phase species found were *F. boloniensis*, *O. favulata*, *P. mountfieldensis*, *Damonella pygmaea*, *E. weedonensis*, *T. forbesii* and *R. jurassica*.

Only two samples were taken from the **Swanage Cycle.** These yielded the C-phase species *C. coelnothi*, *C. delicatula*, *C. granulosa granulosa* and *C. simplex*. The S-phase forms were *T. forbesii*, *Klieana sp.*, *Darwinula leguminella*, *D. oblonga* and *Damonella pygmaea*.

The **Ashdown Cycle** (44 ft 6 in to 49 ft) contained the following C-phase forms: *C. coelnothi*, *C. granulosa granulosa*, *C. granulosa protogranulosa*, *C. sagena*, *C. simplex* and *C. tumescens tumescens*. The S-phase species were *Darwinula leguminella*, *Damonella pygmaea*, *T. forbesii*, *P. mountfieldensis* and *F. boloniensis*.

In the **Goldspur Cycle** (49 to 60 ft) ostracods were rare and *C. granulosa protogranulosa* was the only species found.

LOWER PURBECK (195 ft of strata, i.e. 60 to 255 ft)

The **Mountfield Cycle** was well represented between 60 ft and 69 ft 6 in. The C-phase fauna from the upper part of the cycle consisted of *C. dunkeri carinata*, *C. sagena*, *C. granulosa protogranulosa*, *C. simplex* and *C. tumescens praecursor*. The S-phase species, which were especially abundant in the lower part of the cycle, were *S. trapezoides*, *Damonella ellipsoidea*, *D. pygmaea*, *D. buchaniana*, *Darwinula leguminella*, *R. jurassica*, *F. boloniensis*, *P. mountfieldensis*, *B. striata*, *T. forbesii* and *K. thoracina*.

Ostracods were not particularly abundant in the **Burwash Cycle** (69 ft 6 in to 73 ft 6 in) but the following C-phase forms were recovered: *C. dunkeri carinata*, *C. granulosa protogranulosa*, *C. peltoides peltoides*, *C. simplex* and *C. tumescens praecursor*. The S-phase species present were *P. mountfieldensis*, *Damonella ellipsoidea*, *D. pygmaea*, *F. boloniensis* and *R. jurassica*.

From the **Robertsbridge Cycle** which extended from 73 ft 6 in to 78 ft 5 in the following C-phase species were collected: *C. dunkeri carinata*, *C. peltoides peltoides*, *C. tumescens praecursor* and the S-phase species *F. boloniensis*, *P. mountfieldensis* and *R. jurassica*.

In the **Ringstead Cycle** (78 ft 5 in to 82 ft 9 in) the only species found were *F. boloniensis* and *E. mountfieldensis*.

No ostracods were seen in the **Penshurst Cycle** but in the **Upper Soft Cockle Cycle** (87 ft 11 in to 104 ft 6 in) the following C-phase species were found: *C. dunkeri inversa*, *C. granulosa protogranulosa*, *C. peltoides peltoides*, *C. simplex* and *C. tumescens acrobeles*. The S-phase species present were *F. boloniensis* and *P. mountfieldensis*.

The **Lower Soft Cockle Cycle** is thought to have occupied the strata between 104 ft 6 in and 133 ft but no ostracods were found.

In the **Wardour Cycle** (133 to 145 ft) the C-phase species were *C. dunkeri inversa*, *C. peltoides peltoides* and *C. tumescens acrobeles*, whilst the S-phase forms, mostly from below 143 ft, were *M. cyrton*, *Darwinula oblonga* and *M. purbeckensis*.

The **Hard Cockle Cycle** (145 to 177 ft) contained the C-phase species *C. dunkeri inversa* and *C. tumescens acrobeles*, and the S-phase forms *Damonella ellipsoidea*, *M. cyrton*, *F. boloniensis* (the dominant species) and *Darwinula oblonga*.

The lowest ostracods found in the Goldspur Drift were in the **Swindon Cycle** at 198 ft 8½ in where the S-phase species *F. boloniensis*, *F. ansata* and *M. purbeckensis* were found. No C-phase ostracods were seen.

The top of the Portland Beds is estimated to be about 255 ft.

Milkhurst Wood Stream Section

The lowest beds seen in this section (Plate I) at 1400 ft downstream from the bridge were part of the **Durlston Cycle.** They were pyritous greenish grey clays with *Chara* gyrogonites, fish debris and the following ostracods: C-phase species, *C. coelnothi*, *C. granulosa fasciculata*, *C. granulosa protogranulosa*, *C. lata lata*, *C. sagena*, *C. posticalis*, *C. primaeva*, *C. simplex*, *C. swanagensis*, *C. tumescens tumescens*, *C. varians*; S-phase species, *B. dilatata*, *B. striata*, *Damonella buchaniana*, *D. ellipsoidea*, *D. pygmaea*, *Darwinula leguminella*, *D. oblonga*, *Eoparacypris attenuata*, *F. boloniensis*, *Mantelliana almana*, *P. mountfieldensis*, *R. jurassica*, *S. trapezoides*, *T. mackerrowi*.

C-phase species accounted for 65 per cent of the fauna. *C. swanagensis* was the dominant form. *C. posticalis* is an important species characteristic of the Netherfield and Durlston Cycles.

At 1190 ft downstream from the bridge were shelly clays which represent the lower part of the **Cinder Beds Cycle.** Here only the S-phase species *K. dictyota* and *Procytheropteron brodiei* were found above a 3-in hard band, with crushed foraminifera.

A horizon higher in the Cinder Beds Cycle was exposed between 1075 and 1125 ft downstream from the bridge. Ostracods were fairly common but only S-phase species were represented. In the sixteen samples examined *G. postsinuata* was the dominant form and accounted for 63 per cent of the individuals found, *K. dictyota* accounted for 27 per cent and *O. cineraria* for 9 per cent, whilst the remaining 1 per cent was made up of *P. brodiei*, *S. arkelli* and *T.* cf. *mackerrowi*. The top of the Cinder Beds S-phase was exposed at 980 ft below the bridge and contained a similar fauna. The C-phase of the Cinder Beds Cycle was seen at 900 ft below the bridge. Here the fauna consisted of *C. lata lata*, *C. sagena* (the dominant species) and *C. simplex*, representing 93 per cent of the fauna, the remainder being the S-phase forms *G. postsinuata* and *Darwinula leguminella*.

The highest shales of this cycle contained much plant debris and were succeeded by pyritous shales belonging to the S-phase of the **Nothe Cycle** which contained the ostracods *Darwinula oblonga*, *G. postsinuata* (the dominant species) and *K. dictyota*. These species accounted for 60 per cent of the fauna the remaining 40 per cent being made up of *C. sagena* and *C. simplex*.

The C-phase of the Nothe Cycle yielded no ostracods except for a few indeterminable fragments of *Cypridea* at 680 ft below the bridge, but the shales were full of plant debris and lignite.

At 650 ft below the bridge grey ferruginous shales contained a fauna representing the S-phase of the **Croydon Cycle,** viz. *B. striata*, *Darwinula leguminella*

and *D. oblonga*, which together comprised 84 per cent of the fauna accompanied by a few specimens of *C. granulosa fasciculata.*

All the beds seen above this level, shales and thin sandstones, were full of lignite, plant and fish debris but no ostracods were found until the bridge was reached. The shales seen just above the bridge for the first 4 ft belonged to the C-phase in the upper part of the **Langton Cycle** and yielded *C. acuta*, *C. amisia*, *C. lata senilis* and *C. vidrana* together with a few S-phase species, mainly Darwinulids.

At the top of the section the first S-phase of the **Scallop Cycle** was found containing the characteristic species *Darwinula leguminella*, *Macrodentina mediostricta* and *K. dictyota* which together accounted for 77 per cent of the fauna, the remainder being indeterminate fragments of *Cypridea spp.* This was succeeded by a C-phase 18 in thick, which was exposed 75 ft upstream from the bridge and yielded *C. acuta*, *C. amisia*, *C. bimammata*, *C. lata senilis* (the dominant species), *C.* cf. *martini*, *C. simplex*, and *C. vidrana.* The next 12-in above contained a second S-phase with *K. dictyota* and *M. mediostricta.* This alternation of C- and S-phases near the middle of a cycle and between the main lower S-phase and the main upper C-phase is a common feature often seen when ostracods are abundant enough to make detailed sampling possible. A good example of this is recorded from the Poxwell Cycle of the Warlingham Borehole.

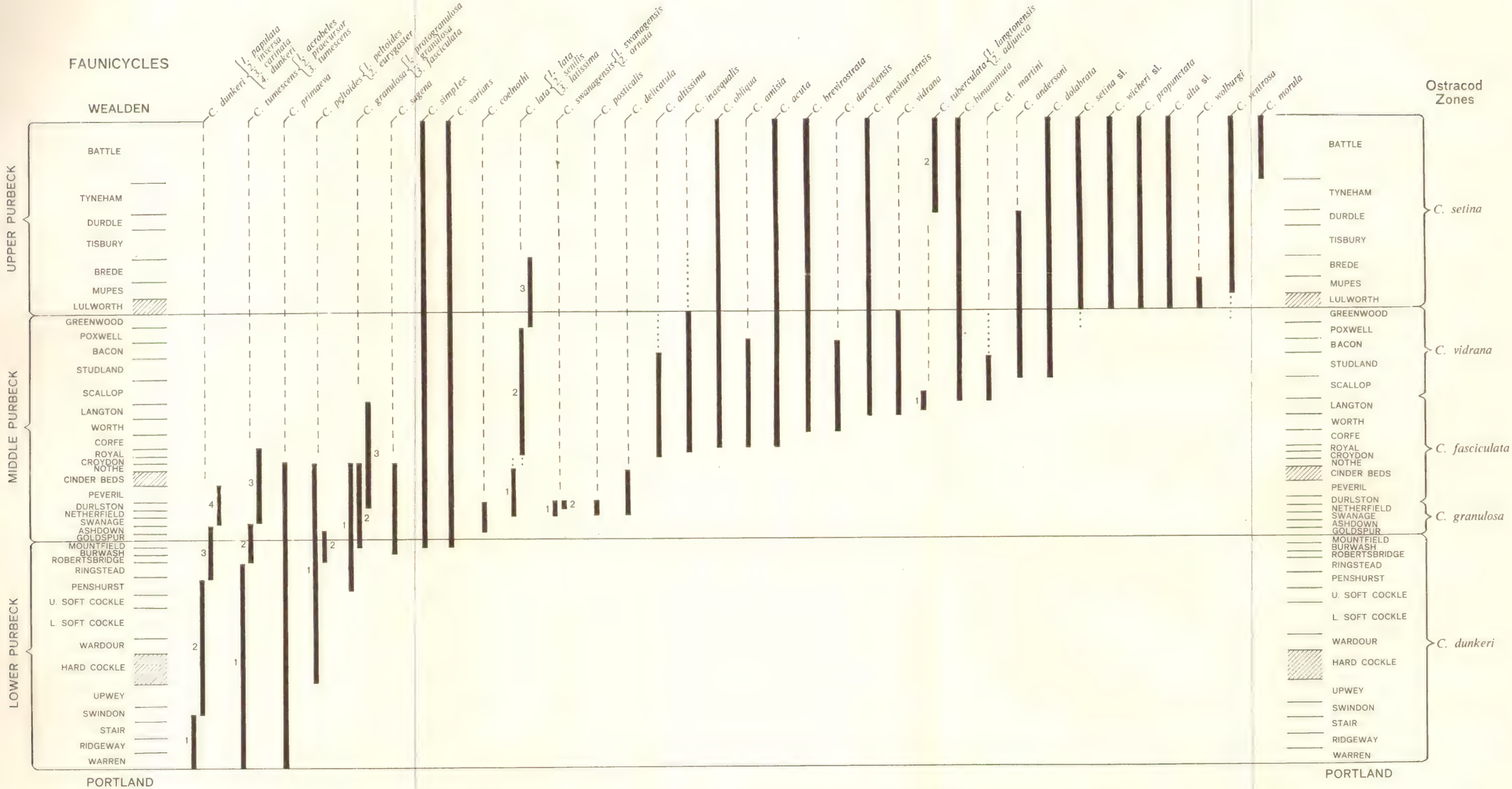
Nine Acre Wood Stream Section

The sequence of strata exposed in Nine Acre Wood (Plate I) was similar but less extensive than that in Milkhurst Wood. The lowest beds seen, 420 ft upstream from the confluence with the River Dudwell, represented the top (C-phase) of the **Durlston Cycle** and contained the characteristic species *C. posticalis* together with *C. coelnothi*, *C. delicatula*, *C. lata lata*, *C. simplex*, *C. swanagensis* (the dominant form), *C. tumescens tumescens* and *C. varians*, together with a few S-phase species, viz. *Damonella ellipsoidea*, *Darwinula oblonga* and *R. jurassica.*

A short distance upstream (at 525 ft) slightly higher beds yielded *C. coelnothi*, *C. delicatula*, *C. granulosa fasciculata* (the dominant species), *C. granulosa granulosa*, *C. lata lata*, *C. peltoides peltoides*, *C. granulosa protogranulosa* and *C. simplex.* These C-phase species accounted for from 80 to 90 per cent of the fauna, the rest of which was made up of the S-phase forms: *Bisulcocypris striata*, *B. dilatata*, *Damonella pygmaea*, *Darwinula leguminella*, *D. oblonga*, *Mantelliana almana* and *T. forbesii.*

Immediately above, 3 ft of soft brown shales contained the S-phase fauna of the **Peveril Cycle,** i.e. *B. striata*, *D. leguminella*, *F. boloniensis*, *M. almana* and *S. trapezoides.* Throughout these shales the S-phase species accounted on average for 97 per cent of the fauna. *F. boloniensis* was the dominant form (92 per cent). The few C-phase species present were *C. delicatula*, *C. granulosa fasciculata* and *C. lata lata.* Above, the C-phase of this cycle (86 per cent C-phase species) contained *C. delicatula*, *C. granulosa fasciculata* and *C. lata lata* together with a few examples of the S-phase species found below.

From 750 to 850 ft upstream the S-phase of the **Cinder Beds Cycle** was exposed and from seven samples the following ostracods were collected: *G. postsinuata*, *K. dictyota*, *O. cineraria* and *Procytheropteron brodiei.* As in the



Stratigraphical Distribution of the Species and Subspecies of the Ostracod Genus *Cypridea*

Milkhurst Wood section *G. postsinuata* was the dominant species and together with *K. dictyota* accounted for most of the fauna (83 per cent).

Although the remainder of the section was sampled almost continously up to a point 1700 ft upstream from the River Dudwell, only traces of indeterminate ostracods were found. The beds consisted of shales and sandstones with abundant lignite. The section probably ended not far below the base of the Scallop Cycle.

Binglett's Wood Stream Section

This stream section (Plate I) exposed higher strata than were seen in either the Milkhurst Wood or the Nine Acre Wood sections. The lowest beds seen just downstream of a bridge over the River Dudwell were grey shelly shales, 1 ft 6 in thick, which contained gastropods, otoliths and other fish debris and the following ostracods: *C. inaequalis*, *C. lata senilis*, *C. simplex*, and *C. vidrana*. This is a fauna from the C-phase of the **Scallop Cycle.**

At 190 ft upstream from the bridge part of the S-phase of the **Studland Cycle** was seen. Here grey shales, 4 ft 6 in thick, contained *B. striata*, *Damonella buchaniana*, *Darwinula leguminella*, *D. oblonga* and *R. jurassica*. In the upper 2 ft 6 in of these shales only Darwinulids were found, suggesting a transition to the C-phase above, in which, however, no ostracods were found. The strata up to 380 ft above the bridge were silty with much lignite and only fragmentary and indeterminable remains of ostracods.

At 380 ft above the bridge in shelly lignitic shales a fauna was recovered transitional to the **Bacon Cycle** S-phase above. It consisted of Darwinulids (42 per cent) with *C. simplex* and *C. vidrana*. In the next 6 in *Macrodentina mediostricta* appeared with *C. penshurstensis*, *C. acuta* and Darwinulids, and 6 in higher still, S-phase species accounted for 60 per cent of the fauna, viz. *Darwinula leguminella*, *D. oblonga*, *Eoparacypris macroselina* and *R. jurassica*, with a few examples of *C. acuta* and *C. penshurstensis*. This assemblage was found for a further 6 in and the horizon is probably not far below that met with 580 ft above the bridge in which *B. striata* is the dominant species.

Only crushed and unidentifiable ostracods were found in the C-phase of the Bacon Cycle which appears to have extended to about 700 ft above the bridge. The beds were silty and contained much lignite.

Near the top of the section, at 700 ft, a green shelly and pyritous clay contained only *R. jurassica* and may mark the position of the S-phase of the **Poxwell Cycle.** Twelve inches higher a grey shale contained: *B. striata*, *C. bimammata*, *C. penshurstensis* and Darwinulids.

The River Line Section (see Plate IV)

A detailed section of the strata exposed in the River Line has been published by Howitt (1964, pp. 84, 86), but very few ostracods were collected and because of this, of gaps in the section, and of the difficulty of recognizing lithological units in the Purbeck of the Weald in general, it has not been possible to correlate this section in detail with that seen in the boreholes.

So far as can be estimated the lowest beds seen in the section south-westwards from the mine were in the upper part of the **Upper Soft Cockle Cycle.** A sample collected by Dr. Bazley from near this horizon [TQ 7177 1918] consisted of a

solid mass of partly decalcified ostracods, specifically unidentifiable but apparently Lower Purbeck forms.

The **Goldspur Cycle** marking the base of the Middle Purbeck was probably located about 30 ft above this, and the base of the **Cinder Beds** is estimated to be about 45 ft higher still. Dr. Bazley collected samples a few feet above this level which contained a fauna typical of the Cinder Beds, i.e. *G. postsinuata* and *K. dictyota.*

The base of the **Upper Purbeck** is estimated to be about 70 ft below the top of the section seen north-eastwards from the mine. Above this level Dr. Howitt collected a few samples of *C. setina setina* and *C. dolabrata*, definite Upper Purbeck species.

The highest beds seen are shales probably belonging to the **Battle Cycle.**

Though it has proved impossible to correlate individual beds, the thicknesses of the subdivisions of the Purbeck in the River Line section appear to be similar to those found in the Mountfield and Heathfield boreholes.

Correlation with the Purbeck Beds of Dorset

Lithologically the Purbeck Beds in Dorset are in general very different from those in the Weald, especially in the middle and upper divisions, but although the ostracod faunas of the former are poorer in species and mostly less well preserved than those of the latter the same sequence of ostracod faunas obtains in both areas and a reasonably accurate correlation is possible.

Evidence suggests that the brackish-lagoon conditions of the Purbeck became established first in the north and north-west, i.e. in Buckinghamshire (Aylesbury area) and Wiltshire (Swindon), somewhat later in Dorset and later still in the Weald. In the Aylesbury area (Barker 1966b) and at Swindon (Sylvester-Bradley 1941b) there appears to have been an alternation of Portland and Purbeck conditions before the end of Portland times as defined in the type area. In Dorset the end of the Portland was marked by an elevation of the sea floor which then became covered with vegetation now represented by 'dirt beds'. The first deposits to follow were tufaceous and bituminous limestones, the Hard and Soft Caps (in Damon's section, 1884, Beds 1–5). These appear to represent the Warren and Ridgeway cycles which in the Weald comprise gypsum interbedded with thin limestones and marls, and where evaporite conditions persisted through the Stair and into the Swindon Cycle. It is suggested that the Broken Bands (Bed 6) seen in the coast sections at Durlston, Worbarrow and Mupes in Dorset represent this part of the sequence, i.e. that the Broken Bands were originally a sequence of gypsum, limestone and marls from which the gypsum has since been leached out leaving a mass of collapsed and broken up limestones resembling an edgewise conglomerate.

The '*Cypris* Freestones' (Beds 7–11) of Dorset are marls, shales and limestones which represent the bulk of the Swindon and Upwey cycles, in the S-phases of which *F. boloniensis* and *M. purbeckensis* are the dominant species. The Adit and Icehouse Limestones of the Mountfield area appear to be in this part of the sequence.

The Hard Cockle Beds (Bed 12) which form part of the Hard Cockle Cycle at Durlston are mainly limestones and shales but farther east in Dorset include

much hard and often sandy limestone. The Dunkshaws Limestone of the Battle area appears to be the equivalent horizon in the Weald.

The Soft Cockle Beds (Beds 13–19) form the upper part of the Lower Purbeck at Durlston and comprise the Wardour to Mountfield cycles inclusive. They appear to be the equivalent of the Rounden Greys (Wardour to Lower Soft Cockle cycles) and the Blues (Penshurst to Mountfield cycles) of the Weald. *C. peltoides*, which first appears in the Hard Cockle Cycle in the Weald, is found in the basal marls of the Soft Cockle Beds at Durlston (Bed 13).

In the Middle Purbeck the ostracod faunas are more varied and correlation between the eastern and western basins is on firmer ground. The Marly Freshwater Beds (Beds 20–24) contain at the base the first examples of *C. granulosa granulosa*, which appears for the first time in the Goldspur Cycle, and apparently comprise the Goldspur, Ashdown and Swanage cycles.

The Cherty Freshwater Beds (Beds 25–42) include the Netherfield, Durlston and Peveril cycles. *C. posticalis*, known in the Weald only from the Netherfield and Durlston cycles, is found in these beds at two horizons (Beds 26 and 28) in Durlston Bay. *C. granulosa fasciculata*, which first appears in the Durlston Cycle, is found at Durlston Bay in Bed 30.

The Cinder Beds, the best known of the more saline horizons of the Purbeck, consist at Durlston of a mass of *Liostrea distorta* 9 ft 6 in thick (Beds 43 and 44). In the Weald the Cinder Beds are represented by shales generally about 10 ft thick in which oysters are common, but which never form a shell bed like that in Dorset. But in both places the ostracod fauna has obvious marine affinities, more so than in any other part of the sequence.

The Intermarine Beds (Beds 45–57) range from the Cinder Beds (C-phase) up to and including the Langton Cycle. Throughout *C. granulosa fasciculata* is the common species both in Dorset and the Weald.

The Scallop Beds (Bed 58) in Dorset are a shelly limestone with *Liostrea* at the base and an ostracod fauna similar to that of the Cinder Beds. In the Weald this horizon falls within the 'Arenaceous Beds' and is not recognizable lithologically, but the fauna indicates the marked saline conditions.

The *Corbula* Beds (Beds 59–70) are mainly limestones and alum shales in Dorset and include the Studland and Bacon cycles. The C-phase fauna, which includes a late form of *C. amisia* and *C. vidrana*, and an S-phase fauna dominated by *M. mediostricta* are typical of both the Weald and Dorset.

The Chief 'Beef' Beds (Beds 71–77) are shales and limestones with much 'beef' (fibrous calcium carbonate) and selenite, and comprise the Poxwell and Greenwood cycles, i.e. the 'Beef' Beds of the eastern sequence. In both Dorset and the Weald *C. penshurstensis* and *C. simplex* are the common species.

The base of the Upper Purbeck is marked by the Upper Broken Shell Limestone (Bed 78). Over much of Dorset this is a hard shelly and sandy limestone, 10 ft thick at Durlston. In the Weald no such distinctive marker is seen. Instead this horizon is represented by clays, silts and shales with thin limestones, but the ostracod faunas are essentially the same in both areas. *C. setina* s.l. and *C. penshurstensis* are the dominant C-phase species.

The *Unio* Beds (Beds 79–83). Limestones and shales with an ostracod fauna like that found in the Mupes Cycle in the Weald, viz. *C. alta formosa*, *C. penshurstensis*, *C. propunctata* and *C. setina rectidorsata.*

The Upper *Cypris* Clays and Shales (Beds 84–93). Here again the lithological sequence is very different in the two areas. In Dorset 'Marble' Beds are a characteristic feature but these are not seen in the Weald. This part of the sequence represents the Brede to Tyneham cycles with a characteristic fauna of *C. setina* s.l., *C. propunctata*, *C. penshurstensis*, *C. lata latissima*, *C. alta alta*, *C. alta formosa*, *C. simplex*, *C. ventrosa*, *C. acuta* and *C. tuberculata adjuncta*, all of which are found both in Dorset and in the Weald.

In Durlston Bay the highest cycle of the Purbeck Beds (Battle) is not now exposed except for the lowest 4 ft, which appear to represent part of the S-phase of the cycle; but at Mupes Bay and Ridgeway the cycle is seen to consist of a series of marls and clays (the '*Paludina*' Clays) which are overlain by sandy beds at the base of the Wealden.

Systematic Descriptions[1]

Order PODOCOPIDA Sars, 1866

Family ILYOCYPRIDIDAE Kaufman, 1900

Genus CYPRIDEA Bosquet, 1852

Cypridea acuta sp. nov.

Plate XVI, fig. 5

Holotype. GSM Mik(M) 3198001. Dimensions: length 0·905 mm, height 0·545 mm, length/height ratio 1·66. Locality: Warlingham Borehole, Surrey, at 1946 ft 6 in. Horizon: Poxwell Cycle, *C. vidrana* Zone, Middle Purbeck.

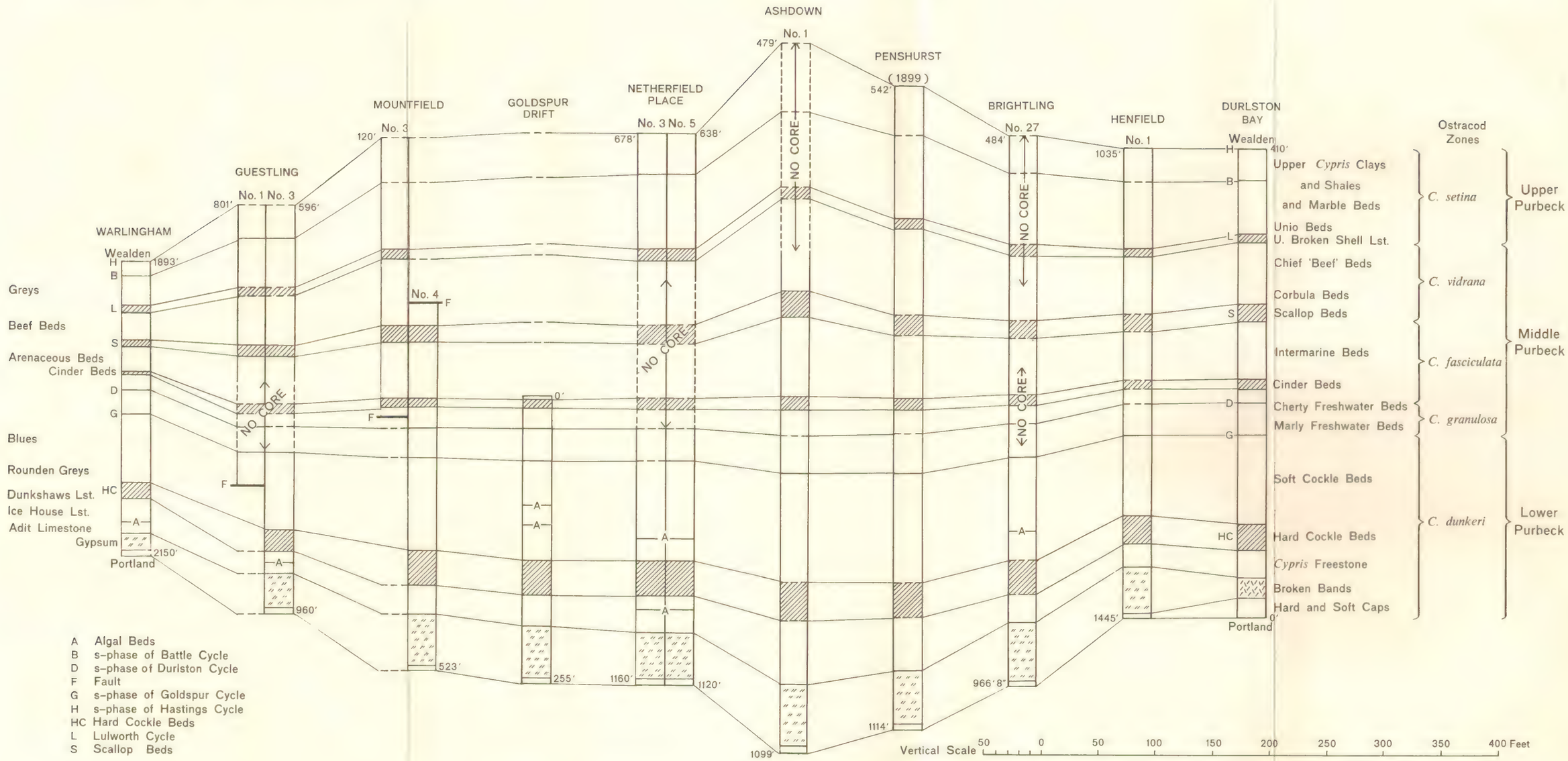
Diagnosis. Carapace triangular-ovate in lateral view, evenly rounded anteriorly. Rostrum small, retroverted; alveolus very small and curved forwards; cyathus small, triangular, terminal. Surface very finely punctate. Right valve the larger.

Description. This form resembles *C. paulsgrovensis* (p. 74, Plate XVI, fig. 6) but lacks the antero-dorsal angle of that species. The rostrum is considerably smaller and is curved strongly backwards, the alveolus is barely distinguishable and the cyathus is smaller and more obtuse. *C. simplex* (p. 85, Plate XVI, fig. 2) is very like *C. acuta* in type of rostrum and general outline but is smaller, has a more acute cyathus and is not an inverse form.

Distribution. C. acuta first appears in the Corfe Cycle (*Cypridea granulosa fasciculata* Zone) of the Middle Purbeck but is comparatively rare until the Bacon Cycle (*C. vidrana* Zone). It is fairly common throughout the Upper Purbeck. The species has been recognized in the Warlingham, Mountfield No. 3, Guestling No. 3, Penshurst (1899), Brightling No. 27 and Henfield No. 1 boreholes and the Milkhurst Wood and Binglett's Wood Stream sections in the Weald; in the Portsdown No. 1, Chilcomb Down No. 1 and Kingsclere No. 1 boreholes in Hampshire; and in the Durlston Bay section in Dorset.

This species is also found in the Hastings Beds.

[1]Collections from which specimens are cited by number are indicated as follows: GSM, Institute of Geological Sciences, London; BM, British Museum (Natural History), London; SMF, Senckenberg Museum, Frankfurt.



Correlation of the Purbeck Beds of the Weald and comparison with the succession in Dorset

Cypridea alta Wolburg

1959. *Cypridea alta* Wolburg, p. 263.

Remarks. Wolburg has divided this variable species into subspecies and varieties all of which are to be found in the English Purbeck. It ranges throughout the Upper Purbeck and into the basal beds of the Wealden (in Germany 'Wealden' 3 and 4). In the Weald it has been found in the Mountfield No. 3, Netherfield Place No. 3 and Warlingham boreholes; in the Kingsclere No. 1, Portsdown No. 1 and Chilcomb Down No. 1 boreholes in Hampshire and in the Durlston Bay section in Dorset. *C. alta wicki* Wolburg is here considered to be a subspecies of *C. wicheri* Wolburg (p. 94).

Cypridea alta alta Wolburg

Plate X, figs. 7–8; Plate XI, figs. 1–3

1862. *Cypridea valdensis:* Jones, pl. v, figs. 26–27.
1959. *Cypridea alta alta* Wolburg, p. 263, pl. iii, figs. 1, 7–8, 10.
1962. *Cypridea alta alta:* Anderson, pl. ii, figs. 1, 3–4.

Holotype. SMF Xe 3295. Dimensions: length 1·135 mm, height 0·85 mm, length/height ratio 1·34. Locality: Bohrung Georgsdorf 97, Germany, at 830 to 840 m. Horizon: 'Wealden' 4, middle.

Figured Specimens. GSM Mik(M) 3182001 (Plate X, fig. 7). Dimensions: length 0·905 mm, height 0·65 mm, length/height ratio 1·39. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1737 ft. Horizon: Battle Cycle, *C. setina* Zone, Upper Purbeck.

GSM Mik(M) 3183001 (Plate X, fig. 8). Dimensions: length 0·895 mm, height 0·625 mm, length/height ratio 1·43. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1732 ft. Horizon: Battle Cycle, *C. setina* Zone, Upper Purbeck.

GSM Mik(M) 3184001 (Plate XI, fig. 1). (Paralleloid variety of Wolburg.) Dimensions: length 0·985 mm, height 0·68 mm, length/height ratio 1·45. Locality: Portsdown No. 1 Borehole, Hampshire, at 2290 to 2295 ft. Horizon: uncertain, probably Upper Purbeck.

GSM Mik(M) 3185001 (Plate XI, fig. 3). (Inflated variety of Wolburg.) Dimensions: length 0·960 mm, height 0·705 mm, length/height ratio 1·36. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1753 ft. Horizon: Tisbury Cycle, *C. setina* Zone, Upper Purbeck.

GSM Mik(M) 3186001 (formerly Mik(M) 494005) (Plate XI, fig. 2). (Angulatoid variety of Wolburg.) Dimensions: length 0·97 mm, height 0·70 mm, length/height ratio 1·38. Locality and horizon as Plate X, fig. 8.

Description. It is sometimes difficult to distinguish between *C. alta alta* and the contemporary species *C. propunctata* (p. 79, Plate IX, figs. 1, 2). The latter, however, is more coarsely punctate and the postero-ventral margin is evenly convex instead of slightly concave as in *C. alta.* Again, the left valve in *C. alta* is larger than the right valve all round but in *C. propunctata* the valves are the same height at the dorsal margin.

Wolburg has described several varieties of *C. alta alta* all of which are also found in England. The specimen here figured in Plate X, fig. 7 compares well with the holotype (Wolburg, pl. iii, fig. 1), that in Plate X, fig. 8 is a lower form. The specimen in Plate XI, fig. 1 is the paralleloid form of Wolburg (1959,

pl. iii, fig. 8); that in Plate XI, fig. 3 is the inflated variety (Wolburg, pl. iii, fig. 7) and that in Plate XI, fig. 2 is the angulatoid variety (Wolburg, pl. iii, fig. 10). Exaggeration of the features characteristic of this angulate variety leads to the subspecies *C. alta formosa*. In 1959 (p. 262) Wolburg cited *C. valdensis* (of Jones 1862, pl. v, figs. 26, 27) in the synonymy of *C. alta alta*. The former figure may represent *C. tumescens* s.l.; the latter is indeterminate, possibly not a *Cypridea*.

Distribution. The subspecies ranges from the Lulworth to the Battle cycles, i.e. throughout the Upper Purbeck.

Cypridea alta formosa Wolburg

Plate XI, figs. 4–8

1959. *Cypridea alta formosa* Wolburg, p. 264, pl. iii, figs. 2, 11–2.
1962. *Cypridea alta formosa:* Anderson, pl. ii, figs. 2, 6.

Holotype. SMF Xe 3300. Dimensions: length 1·28 mm, height 0·91 mm, length/height ratio 1·41. Locality: Bohrung Ostenwalde 2, Germany, at 1326 m. Horizon: 'Wealden' 3, middle.

Figured Specimens. GSM Mik(M) 3187001 (Plate XI, fig. 4). Dimensions: length 0·935 mm, height 0·695 mm, length/height ratio 1·34. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1737 ft. Horizon: Battle Cycle, *C. setina* Zone, Upper Purbeck.

GSM Mik(M) 3188001 (Plate XI, fig. 8). Dimensions: length 1·00 mm, height 0·79 mm, length/height ratio 1·29. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1769 ft. Horizon: Lulworth Cycle, *C. setina* Zone, Upper Purbeck.

GSM Mik(M) 3189001 (Plate XI, fig. 7). Dimensions: length 0·97 mm, height 0·76 mm, length/height ratio 1·28. Locality and horizon as Plate XI, fig. 8.

GSM Mik(M) 3190001 (Plate XI, fig. 6). Dimensions: length 1·03 mm, height 0·825 mm, length/height ratio 1·25. Locality: Warlingham Borehole, Surrey, at 1931 ft 2 in. Horizon: Lulworth Cycle, *C. setina* Zone, Upper Purbeck.

GSM Mik(M) 3191001 (Plate XI, fig. 5). Dimensions: length 1·03 mm, height: 0·85 mm, length/height ratio 1·21. Locality: Warlingham Borehole, Surrey, at 1928 ft. Horizon: Mupes Cycle, *C. setina* Zone, Upper Purbeck.

Description. The characteristic shape of this subspecies is unmistakable except that there is a superficial resemblance to *Cypridea dolabrata angulata*, but the latter is even more finely punctate than *C. alta formosa*, and in fact is generally smooth and is without the sinuous curve which marks the postero-ventral margin of *C. alta formosa*.

This subspecies is one of the most noticeable forms in the Upper Purbeck of England ('Wealden' 3 of Germany) to which it is confined, and forms with even higher carapaces than those recorded by Wolburg are found, with length/height ratios as low as 1·21.

This subspecies is only known from the Upper Purbeck beds.

Cypridea altissima Martin

Plate XII, fig. 8; Plate XIII, fig. 1, Text-fig. 8

1940. *Cypridea altissima* Martin, p. 310, pl. iv, figs. 45–7.
1949. *Cypridea* aff. *altissima:* Wolburg, p. 351, pl. ii, figs. 1a–c.
1959. *Cypridea altissima:* Wolburg, p. 247, pl. i, figs. 4, 13.
1962b. *Cypridea altissima:* Wolburg, pl. xxix, figs. 7–8.

Holotype. SMF No. X/E 227. Dimensions: length 1·2 mm, height 0·95 mm, length/height ratio 1·26. Locality: Bohrung Thören WA 1, Germany, at 756 m. Horizon: 'Wealden' 2 of Germany.

Figured specimens. GSM Mik(M) 3301001 (Plate XII, fig. 8). Dimensions: length 1·07 mm, height 0·83 mm, length/height ratio 1·29. Locality: Warlingham Borehole, Surrey, at 1962 ft 11 in. Horizon: Scallop Cycle, *C. vidrana* Zone, Middle Purbeck.

GSM Mik(M) 3159001 (Plate XIII, fig. 1). Dimensions: length 1·12 mm, height 0·88 mm, length/height ratio 1·33. Locality: Mountfield No. 3 Borehole, Sussex, at 297 ft. Horizon: Langton Cycle, *C. g. fasciculata* Zone, Middle Purbeck.

Description. The possibility of this species being an unornamented subspecies of *C. granulosa* is discussed by Wolburg (1962b) and here on p. 64. According to Wolburg (1959, p. 248) the common form of *C. altissima* which he restricted as the subspecies *altissima* has an average length/height ratio of 1·28 (range 1·18 to 1·44), with lengths ranging from 0·96 to 1·25 mm, and heights from 0·7 to 1·02 mm. English examples are generally lower with an average length/height ratio of 1·39 (range 1·26 to 1·56), lengths ranging from 0·99 to 1·215 mm and heights from 0·65 to 0·92 mm, but many are still very like the German examples in outline (compare Plate XII, fig. 8 with Martin's pl. iv, fig. 45).

Wolburg's subspecies *rotunda* (1959, p. 249, pl. i, fig. 5) has not been recognized with certainty in the English Purbeck, nor do any of the English examples of the genus so far seen show a postero-dorsal swelling (Wulst or Knoten) on the right valve like that illustrated by Wolburg.

Distribution. According to Wolburg *C. altissima* is characteristic of the lower part of 'Wealden' 2 which appears to be the horizon equivalent to the Corfe to Scallop cycles in the English Purbeck. In England it occurs in the *C. granulosa fasciculata* and *C. vidrana* Zones.

The earliest record of the species in England is a single dubious example from the Chilcomb Down No. 1 Borehole in the Croydon Cycle. In the Royal, Corfe and Worth cycles above several specimens were found in the Guestling No. 3, Ashdown No. 1 and Mountfield No. 3 boreholes in Sussex and the Chilcomb Down No. 1 Borehole in Hampshire. In the Langton Cycle typical examples of the species were found comprising up to 70 per cent of the fauna in the Mountfield Nos. 3 and 4 boreholes. In the Scallop Cycle *C. altissima* reaches its maximum development in the Brightling No. 27 and Mountfield No. 3 boreholes; high forms with length/height ratios of 1·28 are common.

The only record of the species from Dorset is from the Studland Cycle at Durlston Bay. Only doubtful examples were found in the Bacon and Poxwell cycles of the Brightling No. 27 Borehole.

Cypridea amisia Wolburg

Plate IX, figs. 5–8

1959. *Cypridea amisia* Wolburg, p. 257, pl. ii, fig. 7.

Holotype. SMF Xe 3288. Dimensions: length 1·01 mm, height 0·68 mm, length/height ratio 1·48. Locality: Bohrung Rühlertwist 3, Germany, at 1228 m. Horizon: lower part of 'Wealden' 2.

Figured Specimens. GSM Mik(M) 3211001 (Plate IX, figs. 5, 6). Dimensions: length 0·99 mm, height 0·69 mm, length/height ratio 1·43. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1795 ft. Horizon: Langton Cycle, *C. g. fasciculata* Zone, Middle Purbeck.

GSM Mik(M) 3351001 (Plate IX, figs. 7, 8). Dimensions: length 1·08 mm, height 0·74 mm, length/height ratio 1·46. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1809 ft. Horizon: Royal Cycle, *C. g. fasciculata* Zone, Middle Purbeck.

Description. In England this species is especially characteristic of the highest beds of the *C. g. fasciculata* Zone where high forms are developed. In its typical form the species is fairly easily distinguished by a somewhat rectangular outline and slightly sinuous ventral margin (Plate IX, figs. 5–6). Earlier forms like that from the Royal Cycle figured as Plate IX, figs. 7–8, are a little more triangular.

C. vidrana appears in the Langton Cycle perhaps as a mutation of *C. amisia*, and the two species are difficult to separate.

Distribution. Forms thought to be *C. amisia* first appear in England in the Nothe Cycle and the species reaches its maximum development in the Langton Cycle (*C. g. fasciculata* Zone). *C. amisia* has not been recognized above the Bacon Cycle (*C. vidrana* Zone).

It has been found in the Mountfield Nos. 3 and 4, Guestling No. 1, Brightling No. 27, Penshurst (1899) and (1938) boreholes in the Weald, in the Milkhurst Wood section in Sussex; in the Chilcomb Down No. 1 Borehole, Hampshire; and the Durlston Bay section in Dorset.

Cypridea andersoni Wolburg

Plate XVIII, fig. 2

1959. *Cypridea andersoni* Wolburg, p. 255, pl. ii, figs. 1, 9.
1962. *Cypridea andersoni:* Anderson, pp. 26–7, pl. ii, fig. 5.

Holotype. SMF Xe 3280, complete carapace. Dimensions: length 1·28 mm, height 0·85 mm, length/height ratio 1·51. Locality: Bohrung Lathen No. 8, Germany, at 1137 m. Horizon: middle of 'Wealden' 3.

Figured specimen. GSM Mik(M) 3193001, right valve. Dimensions: length 1·015 mm, height 0·66 mm, length/height ratio 1·54. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1802 ft. Horizon: Worth Cycle, *C. g. fasciculata* Zone, Middle Purbeck.

Description. This form is generally larger than most of the *C. propunctata* group of species (see p. 78), with a relatively small rostrum and alveolus and a small and inconspicuous cyathus. The dorsal margin curves smoothly backwards from the antero-dorsal angle and the postero-dorsal slope approaches the ventral margin more acutely than in other species of the group. The shell surface is distinctly punctate. None of the British examples reaches the dimensions of the German species.

Distribution. This is not a common species in England. It is found in the upper part of the Middle Purbeck and in the lower two-thirds of the Upper Purbeck (Scallop to Durdle cycles) and is best developed in the Brede Cycle. In Germany *C. andersoni* is not recorded from the Middle Purbeck.

The species has been found in the Henfield No. 1, Penshurst (1899) and Mountfield No. 3 boreholes in Sussex; the Warlingham Borehole in Surrey; and the Kingsclere No. 1 and Chilcomb Down No. 1 boreholes in Hampshire.

Cypridea bimammata Harbort

1907. *Cypridea bimammata* Harbort, p. 489, pl. xiii, fig. 1.
1940. *Cypridea* (634) Wicher, pp. 268–9, pl. iii, fig. 13.
1940. *Cypridea bispinosa:* Martin, p. 300, pl. xii, figs. 169–70.
1949. *Cypridea spinigera* Wolburg, p. 351.
1958. *Cypridea spinigera* Martin, p. 314.
1959. *Cypridea bispinosa bispinosa:* Wolburg, p. 300, pl. v, fig. 3.
1959. *Cypridea bispinosa bimammata:* Wolburg, p. 300, pl. v, figs. 4, 12–4.

Remarks. Cypridea bispinosa Jones is a species characteristic of the Wadhurst Clay (Wealden) but a very similar form is found in the Middle and Upper Purbeck (upper 'Wealden' 2) of Germany which has been recorded by Martin (1940) and Wolburg (1959) as *C. bispinosa.* Anderson (*in* Anderson and others 1967, p. 212) has suggested that the Purbeck examples of this form, which has a similar stratigraphical range in England, are not necessarily conspecific with the Wealden species. Though the differences are small a distinction can be made. The Purbeck form is more coarsely punctate, has a smaller cyathus and frequently carries a fringe of small tubercles along the anterior margin. Moreover, there is a considerable time gap between the last seen examples of these inverse bispinose shells from the Purbeck and the first appearance of *C. bispinosa* in the Wealden.

Both bispinose and unispinose variants of *C. bispinosa* have been described from the Wadhurst Clay (Anderson op. cit.) and it is suggested that the concept of the unispinose species *C. bimammata* should be widened to include bispinose variants such as those figured in Plate XVIII, fig. 5 and by Wolburg (1959) pl. v, fig. 3.

Cypridea bimammata prolifera subsp. nov.

Plate XVIII, fig. 5

1959 *Cypridea bispinosa bispinosa:* Wolburg, p. 300, pl. v, fig. 3.

Holotype. GSM Mik(M) 3325001, complete carapace. Dimensions: length 1·12 mm, height 0·74 mm. Locality: Mountfield No. 3 Borehole, Sussex, at 206 ft 6 in. Horizon: Brede Cycle, Upper Purbeck.

Diagnosis. A subspecies of *Cypridea bimammata* in which the ornament consists of two tubercles on each valve, a subcentral (polar) tubercle and another dorsal to it in the lumbar region.

Distribution. C. bimammata bimammata and *C. b. prolifera* both appear to have the same range though the latter is by far the most common. The species is first seen in the Scallop Cycle (Middle Purbeck, *C. g. fasciculata* Zone) and is found, though never abundantly, up to and including the Tisbury Cycle (Upper Purbeck). In the Weald *C. b. prolifera* has been recovered from the Warlingham, Mountfield No. 3, Guestling No. 1 and Guestling No. 3 boreholes and the Milkhurst Wood section. In Hampshire it was found in the Kingsclere No. 1 and Chilcomb Down No. 1 boreholes.

Cypridea brevirostrata Martin

Plate XV, fig. 2

1940. *Cypridea brevirostrata* Martin, p. 300, pl. iii, figs. 32–5.
1959. *Cypridea brevirostrata:* Wolburg, p. 304, pl. v, figs. 9–11, 19.
1962a. *Cypridea brevirostrata:* Wolburg, p. 213, pl. xxxib, figs. 19a, b, 20.

Holotype. SMF X/E 199. Dimensions: length 1·10 mm, height 0·75 mm, length/height ratio 1·48. Locality: Bohrung Thören WA 1, Germany, at 753 m. Horizon: 'Wealden'.

Figured Specimen. GSM Mik(M) 3197001. Dimensions: length 1·07 mm, height 0·755 mm, length/height ratio 1·42. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1801 ft. Horizon: Worth Cycle, *C. g. fasciculata* Zone, Middle Purbeck.

Description. The form described by Martin as *C. brevirostrata* is distinguished amongst the inverse species by possessing a small rostrum and alveolus and an inconspicuous, very obtuse triangular-lunate cyathus. The specimen figured here on Plate XV, fig. 2, one of the earliest examples of the species seen in England (Worth Cycle), is very close to one of the paratypes illustrated by Martin (1940, pl. iii, fig. 33).

The ostracod figured by Wolburg (1959, pl. v, fig. 5) as *C. paulsgrovensis* is very like some of the more depressed forms of *C. brevirostrata* and is similar to the specimen figured by Martin (op. cit.) in pl. iii, fig. 33. It is unlike *C. paulsgrovensis* in that the rostrum is too small, it lacks the characteristic cyathus of that species and is also considerably larger.

The majority of the specimens of *C. brevirostrata* seen have a finely punctate surface but in some the shell may be almost smooth. Elevated forms like those illustrated by Wolburg (1959, pl. v, figs. 9–10) are a common variant especially in the lowest Wealden strata.

Distribution. In England *C. brevirostrata* ranges from the Worth Cycle of the Middle Purbeck (*C. g. fasciculata* Zone) through the Upper Purbeck into the lowest beds of the Wealden. In Germany it ranges from the middle of 'Wealden' 2 to the lowest beds of 'Wealden' 4.

The species has been found in the Mountfield No. 3, Brightling No. 27, and Henfield No. 1 boreholes in the Weald; in the Portsdown No. 1, Kingsclere No. 1 and Chilcomb Down No. 1 boreholes in Hampshire; and in the Durlston Bay and Worbarrow Bay sections in Dorset.

Cypridea coelnothi sp. nov.

Plate XIII, fig. 3

1968. ?*Cypridea* aff. *granulosa:* Wienholz, pl. ii, fig. 16.

Holotype. GSM Mik(M) 3160001, left valve only. Dimensions: length 1·01 mm, height 0·66 mm, length/height ratio 1·53. Locality: Netherfield Place No. 5 Borehole, Sussex, at 893 ft 11 in to 894 ft. Horizon: Durlston Cycle, *C. g. fasciculata* Zone, Middle Purbeck.

Diagnosis. Carapace triangular-ovate in side view. Rostrum large and strong, alveolus long and deep, extending halfway across the shell. Cyathus large, obtuse, triangular. Shell surface coarsely punctate and ornamented with about 20 bluntly conical tubercles. Left valve the larger.

Description. In *C. coelnothi* the shell is not unlike that of *C. peltoides* in shape (Plate VII, figs. 5–9) but is distinguished by its tubercular ornament. The tubercles are distributed over the whole shell surface except for the dorso-median area and tend to be more or less uniform in size. Characteristically the Polar tubercle (15), though generally present (in 70 per cent of cases), is not usually the largest, and the tubercles of the lumbar group (13a, b, c), which are relatively large, are the most common with a percentage occurrence of 82 to 97 per cent. The remaining four primary tubercles are 8d (78 per cent), 8e (70 per cent), 9c (67 per cent), and 7c (67 per cent). The secondary tubercles, generally rather smaller than the primaries, are 11a, 6c, 8e, 14c, e, 2c, 14d, 2b, 11, 12a and 1k (percentage occurrence from 37 to 59 per cent).

Usually there are also present some of the 36 small tertiary tubercles, generally at the anterior end of the shell. The three lumbar tubercles, though found in several species of *Cypridea*, are relatively larger and more conspicuous in *C. coelnothi* and give the ornament pattern a characteristic appearance quite distinct from that of the other tuberculate species such as *C. aculeata* and *C. tuberculata*. In *C. coelnothi* the tubercles are bluntly conical as in *C. tuberculata* and not hemispherical as in *C. granulosa*, but they are fewer and smaller than in the former species. *C. coelnothi* could well be an ancestor of *C. tuberculata*, but after the last appearance of the former many feet of strata intervene from which no tuberculate forms have been recovered, before the first appearance of *C. tuberculata langtonensis*, and an even larger interval before the first *C. tuberculata adjuncta* occurs in the Upper Purbeck.

Distribution. C. coelnothi occurs in the *C. granulosa granulosa* Zone and at the base of the *C. g. fasciculata* Zone. It is first seen in the Ashdown Cycle at the Goldspur Drift, Sussex. It is most abundant in the Netherfield and Durlston Cycles but has not been seen higher. The species has been collected from the Henfield No. 1, Mountfield No. 3, and Netherfield Place No. 5 boreholes and the Milkhurst Wood, Nine Acre Wood, Holman's Wood and Goldspur Drift sections in Sussex.

Cypridea darvelensis sp. nov.

Plate VIII, fig. 8

Holotype. GSM Mik(M) 3167001, right valve only. Dimensions: length 1·075 mm, height 0·705 mm, length/height ratio 1·53. Locality: Warlingham Borehole, Surrey, at 1962 ft 11 in. Horizon: Scallop Cycle, *C. vidrana* Zone, Middle Purbeck.

Diagnosis. Carapace oval in lateral view. Rostrum large, alveolus fairly deep and extending to about one-third of the height of the shell, cyathus medium-sized, obtuse-triangular. Surface closely covered with large punctations. Right valve the larger.

Description. This species is not particularly common except in the Scallop Cycle, where the adult has an average length of 1·081 mm and height of 0·72 mm, length/height ratio 1·47. It is more rounded dorsally than *C. penshurstensis* and is much more coarsely punctate.

Distribution. C. darvelensis first appears in the Worth Cycle (*C. granulosa fasciculata* Zone) and reaches its maximum development in the Scallop Cycle, above which it is rare. It has not been recognized with certainty above the Mupes Cycle (Upper Purbeck).

It has been found in the Warlingham Borehole in Surrey; the Mountfield No. 3 and Brightling No. 27 boreholes in Sussex; the Durlston Bay section in Dorset; and the Chilcomb Down No. 1 Borehole in Hampshire.

Cypridea delicatula sp. nov.

Plate X, fig. 5

Holotype. GSM Mik(M) 3170001, right valve only. Dimensions: length 1·06 mm, height 0·705 mm, length/height ratio 1·5. Locality: Mountfield No. 3 Borehole, Sussex, at 323 ft 6 in. Horizon: Corfe Cycle, *C. g. fasciculata* Zone, Middle Purbeck.

Diagnosis. Carapace triangular-ovate in lateral view, ventral margin slightly sinuous; rostrum medium sized, alveolus rather small, cyathus lunate and terminal; surface covered with medium sized punctations. Right valve the larger.

Description. The smaller rostrum and alveolus and the form of the cyathus in this species distinguish it from both *C. darvelensis* and *C. penshurstensis* (p. 76). It is more depressed and more triangular than *C. darvelensis* and the punctations are finer. It is more coarsely punctate than either *C. menevensis* or *C. penshurstensis* and it is a larger shell than the former species. The average length of *C. delicatula* is 1·046 mm, range 1·015 to 1·090; height averages 0·65 mm, range 0·615 to 0·705 mm; average length/height ratio 1·62, range 1·5 to 1·67.

Distribution. C. delicatula is restricted to the *C. granulosa granulosa* and *C. g. fasciculata* zones. It first appears in the Ashdown Cycle of the Middle Purbeck and reaches its maximum in the Durlston Cycle where elevated forms are common. It has not been seen above the Corfe Cycle. The species has been found in the Warlingham, Mountfield Nos. 3 and 4 and Netherfield Place No. 5 boreholes and the Goldspur Drift, Nine Acre Wood and Milkhurst Wood sections in the Weald; in the Kingsclere No. 1 Borehole in Hampshire; and Durlston Bay in Dorset.

Cypridea dolabrata (Anderson)

1939. *Langtonia dolabrata* Anderson, p. 304, pl. xii, fig. 8; pl. xiii, fig. 14.
1940. *Cypridea angulata* Martin, p. 302, pl. ii, figs. 29–31.
1949. *Cypridea* aff. *angulata:* Wolburg, pp. 351–2.
1959. *Cypridea dolabrata:* Wolburg, p. 260, pl. ii, figs. 2–5, 8.
1962a. *Cypridea dolabrata:* Wolburg, p. 207, pl. xxxia, figs. 13–5.

Diagnosis. Carapace triangular-ovate in lateral view, oval in dorsal view, in anterior view swollen mid-dorsally. Rostrum small, alveolus small and narrow, cyathus narrow lunate. Surface smooth or very finely punctate. Left valve the larger.

Description. This species is a characteristic member of the Upper Purbeck and basal Wealden ostracod faunas both in England and Germany. Evidence of morphological instability is seen from its first appearance: Wolburg reports angulate forms in the Upper Purbeck, and in the basal Wealden assemblages in England these predominate. Amongst the latest survivors are some very elevated gross shells such as that figured in Plate XVI, fig. 9, in which the length/height ratio is 1·25.

C. dolabrata clearly belongs to that group of species which includes *C. setina* and *C. laevigata* but is easily distinguishable by its triangular outline and somewhat larger rostrum.

Distribution. *C. dolabrata* and its subspecies is first encountered in the upper part of the Middle Purbeck in England (Studland Cycle, *C. vidrana* Zone), becomes fairly common in the Upper Purbeck and dies out in the lower part of the Wealden (Hythe Cycle) where the majority of the individuals found belong to the subspecies *angulata* Martin.

In Germany *C. dolabrata* is found throughout most of 'Wealden' 3, i.e. Upper Purbeck of England.

The species has been found in the Warlingham, Mountfield No. 3, Henfield No. 1 and Penshurst (1899) boreholes in the Weald; in the Portsdown No. 1, Kingsclere No. 1 and Chilcomb Down No. 1 boreholes in Hampshire; and in the Durlston Bay Section of Dorset.

C. dolabrata may be divided into three subspecies, as follows.

Cypridea dolabrata dolabrata (Anderson)

Plate XVI, fig. 7

1939. *Langtonia dolabrata* Anderson, p. 304, pl. xii, fig. 8; pl. xiii, fig. 14.

Holotype. GSM Mik(M) 533001 (formerly GSM 60680). Dimensions: length 1·05 mm, height 0·74 mm, width 0·48 mm, length/height ratio 1·42. Locality: Portsdown No. 1 Borehole, Paulsgrove, Hampshire, at 2250–55 ft. Horizon: uncertain but probably Upper Purbeck.

Description. A relatively depressed form of the species with a smooth shell surface. The mid-dorsal swelling is relatively small. This is the form first described by Anderson as *Langtonia dolabrata*. *Langtonia* is clearly a synonym of *Pseudocypridina* Roth, 1933, which could be regarded as a subgenus of *Cypridea*.

Cypridea dolabrata kingsclerensis subsp. nov.

Plate XVI, fig. 10

1959. *Cypridea dolabrata angulata* Martin (punctate variety): Wolburg, pl. ii, fig. 4.

Holotype. GSM Mik(M) 2125001. Dimensions: length 1·15 mm, height 0·825 mm, length/height ratio 1·4. Locality: Kingsclere No. 1 Borehole, Hampshire, at 1334 ft. Horizon: *C. brevirostrata* Zone, Wealden.

Diagnosis. A subspecies in which the shell is generally more elevated than in *C. d. dolabrata* but more depressed than in *C. d. angulata* and in which the shell surface is finely punctate.

Description. Wolburg figured this subspecies as a variety of *C. d. angulata* Martin and in general the shell is closer in outline to *angulata* than to *dolabrata*.

Cypridea dolabrata angulata Martin

Plate XVI, figs. 8, 9

1940. *Cypridea angulata* Martin, p. 302, pl. ii, figs. 29–31.
1959. *Cypridea dolabrata angulata:* Wolburg, p. 260, pl. ii, fig. 3.

Holotype. SMF No. X/E 205. Dimensions: length 1·46 mm, height 1·15 mm, length/height ratio 1·27. Locality: Bohrung Rodewald WA 11, Germany, at 310 310·5 m. Horizon: Wealden.

Figured Specimens. GSM Mik(M) 2126001 (cf. Martin 1940, pl. ii, figs. 29–31) (Plate XVI, fig. 8). Dimensions: length 1·20 mm, height 0·83 mm, length/height ratio 1·38. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1687 ft. Horizon: *C. brevirostrata* Zone, Wealden.

GSM Mik(M) 2127001 (gibbous variety) (Plate XVI, fig. 9). Dimensions: length 1·25 mm, height 0·985 mm, length/height ratio 1·25. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1684 ft. Horizon: *C. brevirostrata* Zone, Wealden.

Diagnosis. A subspecies of *C. dolabrata* in which the mid-dorsal area is swollen into a knob-like protuberance. The shell surface is smooth.

Description. Martin described this form as a separate species but all intermediate stages can be found between specimens like the holotype of *C. dolabrata* and those with the characteristic angular profile of *C. angulata.* Even more gross distortions of the shell are to be found like that figured in Plate XVI, fig. 9.

C. dolabrata angulata bears a superficial resemblance to *C. alta formosa* (Plate XI, figs. 4–8) which is a contemporary form. But the rostrum and alveolus of the former are smaller and the cyathus is lunate instead of triangular.

Cypridea dunkeri Jones

1885b. *Cypridea Dunkeri* Jones, p. 339, pl. viii, figs. 9–10, 17.
1940. *Cypridea 635* Wicher, p. 264, pl. iii, fig. 21.
1940. *Cypridea carinata* Martin, p. 294, pl. i, figs. 9–12.
1940. *Cypridea sowerbyi* Martin, p. 295, pl. i, figs. 13–7.
1940. *Cypridea inversa* Martin, p. 297, pl. ii, figs. 22–6.
non 1940. *?Cypridea dunkeri:* Martin, p. 293, pl. ii, figs. 20–21.
1941. *Ulwellia papulata* Anderson, p. 381, pl. xviii, figs. 8–9.
1949. *Cypridea* (*Ulwellia*) *dunkeri:* Sylvester-Bradley, p. 145.
1951. *Cypridea dunkeri:* Anderson, pp. 209–12.
1955. *Cypridea dunkeri:* Bartenstein and Burri, pl. xxviii.
1963. *Cypridea dunkeri:* Oertli, p. 15, pl. i, figs. 1–8.
1966b. *Cypridea dunkeri:* Barker, p. 470, pl. vii, figs. 1–2.

Lectotype. BM In. 39023. Original of Jones 1885b, pl. viii, fig. 9. Middle Purbeck, Mupes Bay, Dorset. Designated by Sylvester-Bradley, 1949, p. 146.

Diagnosis. Carapace triangular-ovate in side view. Ventral margin of right valve velate, smooth and translucent. Rostrum strong, alveolus long and fairly deep, cyathus large, triangular, sub-terminal. Surface finely punctate and usually ornamented with numerous small conical tubercles. Right valve the larger.

Material. 3600 specimens from the Mountfield No. 4, Netherfield Place Nos. 3 and 5, Guestling Nos. 1 and 3 and Brightling No. 27 boreholes and the Goldspur Drift in Sussex; the Warlingham Borehole in Surrey; the sections at Durlston Bay, Ridgeway and Poxwell in Dorset; the Chilcomb Down No. 1 Borehole in Hampshire and sections at Swindon and near Aylesbury.

Description. Jones (1885b, pl. viii) figured three specimens under the name *Cypridea dunkeri.* Fig. 9 illustrates a carapace in which the left valve is the larger, but the original specimen shows this to be an error. This specimen was chosen by Sylvester-Bradley (1949, p. 146) as lectotype of the species. Jones's fig. 17 is a much better illustration of *C. dunkeri* but the original specimen cannot be identified. Nevertheless, the slab of rock from which the drawing is said to have been made is a mass of shells like that shown in fig. 17.

In 1941, Anderson described as a new species (*Ulwellia papulata*) specimens of *C. dunkeri* from the Purbeck Beds at Swindon and Poxwell. The genus *Ulwellia* was created to include those species of *Cypridea* in which the right valve was the larger, but inversion is not now considered to be a character of generic rank. *C. dunkeri* is now known to be an inverse form.

Martin's species *Cypridea carinata*, *C. sowerbyi* and *C. inversa* are here considered to be subspecies of *C. dunkeri* representing stages in a continuous development of the species. Comparable forms occur in England and in the same stratigraphical order as in Germany.

The ornament in *C. dunkeri* ranges from forms in which the shell is virtually without spines or in which the spines are very small, through moderately spinose to strongly spinose forms. In England, the earliest seen (i.e. those in the lowest Purbeck, Warren, Ridgeway and Stair cycles) are fairly spinose though the spines are generally small. At about the middle of the Lower Purbeck (Upwey and Hard Cockle cycles) weakly ornamented forms appear and it is suggested that *C. inversa* Martin is one of these. Then, in the upper part of the Lower Purbeck, especially in the Burwash and Mountfield cycles and at the base of the Middle Purbeck (Goldspur Cycle), small strongly spinose forms become dominant. At higher horizons the ornament tends to weaken so that in the Durlston Cycle forms similar in lack of ornament but smaller in size of carapace than those of the early Purbeck are prevalent.

When the ornament is fully developed the carapace may bear as many as 57 spines but only 10 per cent of the individuals examined carried this number. The primary tubercles 2c, 7c, 8c, d, f, 9c, 11a, 13b, c, 14b, f, are found in 90 per cent of cases. Of these 11a is in the ocular area, 13b and c are lumbar tubercles, and 8c, d and f form the furcal arc, with 8b and e as well in 80 per cent of cases. The ventral arc is usually poorly developed though 7c and 9c are generally present. The polar tubercle (15), which is dominant in so many species of *Cypridea*, is present in 80 per cent of individuals but is rarely conspicuous. The ornament pattern characteristically shows most tubercles in the posterior half of the shell; the anterior tubercles are usually small.

Though specimens of *C. dunkeri* are found throughout the Purbeck Beds from the top of the Portland Stone to the base of the Cinder Beds, the species undergoes morphological changes which form useful indicators of horizon. Three of the more marked variants have been here selected as subspecies though it must be emphasized that these changes form a continuous series. It is possible that the strength of the tubercular ornament is partly determined by ecological factors, but if so, these have been imposed on an underlying genetically controlled change of a type commonly found in other species of the genus. This point is more fully discussed in the description of the *Cypridea granulosa* species-group (p. 63) which gives the best example of a gradual change in ornament pattern.

Cypridea dunkeri papulata (Anderson)

Plate VII, fig. 4

1941. *Ulwellia papulata Anderson*, p. 381, pl. xviii, fig. 8.
1963. *Cypridea dunkeri:* Oertli, p. 15, pl. i, fig. 6.
1966b. *Cypridea dunkeri:* Barker, p. 470, pl. vii, figs. 1–2.

Holotype. GSM Mik(M) 737001 (formerly GSM 70357). Dimensions: length 1·04 mm, height 0·66 mm, width 0·41 mm, length/height ratio 1·58. Locality: Town Garden Quarries, Swindon, Wiltshire. Horizon: basal Purbeck Beds.

Diagnosis. A large form of the species with fairly numerous moderately-sized tubercles.

Description. The earliest known specimens of *C. dunkeri* from Swindon in Wiltshire are large, generally 1·0 mm or more in length, and are fairly spinose. The cyathus in this subspecies is larger and the surface punctations relatively finer than in the other subspecies.

Distribution. C. dunkeri papulata appears in the highest beds of the Portland Stone and continues through into the lowest Purbeck Beds (Warren, Ridgeway and Stair cycles). It is known from Swindon in Wiltshire, Portisham in Dorset and the Aylesbury district, Buckinghamshire.

Cypridea dunkeri inversa Martin

Plate VII, fig. 2

1940. *Cypridea inversa* Martin, p. 297, pl. ii, figs. 22–6.
1963. *Cypridea dunkeri:* Oertli, p. 15, pl. i, figs. 1–2.

Holotype. SMF No. X/E 194. Bohrung Rodewald WA 11, Germany, at 401·5 m, Lower Serpulit.

Figured Specimen. GSM Mik(M) 3152001. Dimensions: length 0·905 mm, height 0·62 mm, length/height ratio 1·46. Locality: Mountfield No. 4 Borehole, Sussex, at 418 ft. Horizon: Hard Cockle Cycle, *C. dunkeri* Zone, Lower Purbeck.

Diagnosis. A form more elevated than the other subspecies and with reduced ornament.

Description. In his description of *C. inversa* Martin states that the shell is without spines ("keine Knoten oder Stacheln"). In spite of this his name is used here for the subspecies of *C. dunkeri* which is characteristic of the middle part of the Lower Purbeck in England. In the cycles Upwey, Hard Cockle, Wardour and Lower Soft Cockle *C. dunkeri* has very variable ornament ranging from virtually spineless individuals to those in which the spines, though not very numerous, are fairly large. Oertli (1963, pl. i, figs. 1–2) has figured a specimen of *C. inversa* in which there appear to be a few spines. The subspecies, however, differs chiefly from the others in that it is relatively more elevated with a length/height ratio of 1·46 as against 1·58 for *papulata*, 1·55 for *carinata* and 1·62 for *dunkeri.*

Distribution. The majority of the individuals of the species found in the middle part of the Lower Purbeck can be assigned to this subspecies. Above the Penshurst Cycle the majority tend to be smaller, less elevated, and more triangular, approaching the subspecies *carinata.*

Cypridea dunkeri carinata Martin

Plate VII, fig. 3

1940. *Cypridea carinata* Martin, p. 294, pl. i, figs. 9–12.
1963. *Cypridea dunkeri:* Oertli, p. 15, pl. i, figs. 3–4, 7–8.

Holotype. SMF X/E No. 187. Bohrung Thören WA 1, Germany, at 782 m, Serpulit.

Figured Specimen. GSM Mik(M) 3151001, right valve only. Dimensions: 0·88 mm, height 0·555 mm, length/height ratio 1·55. Locality: Mountfield No. 4 Borehole, Sussex, at 331 ft to 331 ft 6 in. Horizon: Goldspur Cycle, *C. g. granulosa* Zone, Middle Purbeck.

Diagnosis. A small, triangular spinose form.

Description. This is the most strongly ornamented and most coarsely punctate subspecies. The cyathus is smaller than in *C. d. papulata* and *C. d. inversa* but larger than in *C. d. dunkeri.*

Distribution. This subspecies is especially characteristic of the upper part of the Lower Purbeck and lowest beds of the Middle Purbeck (Ringstead to Ashdown cycles). It is particularly abundant in the Mountfield and Goldspur cycles but in the last named the ornament tends to be weaker.

Oertli (1963) records this subspecies from the upper part of the Lower Purbeck in the Villemoyenne 2 Borehole (Aisne), France, at 1024–26 m.

Cypridea dunkeri dunkeri Jones

Plate VII, fig. 1

1885b. *Cypridea Dunkeri* Jones, pl. viii, figs. 9–10, 17.
1941. *Ulwellia papulata poxwellensis* Anderson, p. 382, pl. xviii, fig. 9.

Lectotype. As for species.

Figured Specimen. GSM Mik(M) 738001 (formerly GSM 76358). Dimensions: length 0·84 mm, height 0·52 mm, width 0·32 mm, length/height ratio 1·62. Locality: Osmington Mills, Dorset. Horizon: Middle Purbeck.

Diagnosis. The smallest subspecies of the genus with much reduced ornament.

Description. The tubercles in this form are more rounded than spinose, small and relatively few. In the latest specimens seen the tubercles are very insignificant or absent altogether. This is the most depressed form of the species and has the smallest cyathus.

Distribution. The subspecies occurs in the *C. g. granulosa* and *C. g. fasciculata* zones. Typical examples first appear in the Swanage Cycle near the base of the Middle Purbeck. In the cycle above (Netherfield) the ornament is weaker, and in the Durlston and Peveril cycles it is rare. The species has not been recognized with certainty above the latter horizon.

Cypridea granulosa (J. de C. Sowerby)

Text-fig. 8

1836. *Cypris granulosa* J. de C. Sowerby, p. 345, pl. xxi, fig. 4 (*non Cypris granulosa* Robertson, 1880).
1838. *Cypris granulosa:* Mantell, p. 344, pl. xlvi, fig. 9.
1855. *?Cypris granulata:* Forbes *in* Lyell, p. 295, fig. 337c.
1855. *Cypris fasciculata* Forbes *in* Lyell, p. 295, fig. 337b.
1878a. *Cypridea verrucosa* Jones, p. 108, pl. iii, fig. 6.
1885b. *Cypridea granulosa:* Jones, p. 340, pl. viii, figs. 18–21 (var. *paucigranulata*).
1940. *Cypridea granulosa:* Martin, p. 289, pl. i, figs. 5–8.
1940. *Cypridea mammillata* Martin, p. 292, pl. ii, figs. 18–9.
1949. *Cypridea granulosa:* Sylvester-Bradley, p. 135, pl. iii, figs. 1–5, text-figs. 20–21.
1959. *Cypridea granulosa:* Wolburg, p. 243, pl. i, fig. 1.

1959. *Cypridea fasciculata:* Wolburg, p. 246, pl. i, fig 3.
1963. *Cypridea* cf. *granulosa:* Oertli, p. 17, pl. iv, figs. 22–3.
1968. *Cypridea sp.* cf. *granulosa:* Wienholz, pl. ii, fig. 16.

Lectotype. Selected from GSM (Geol. Soc. Coll.) 2678 now GSM Mik(M) 517001, by Sylvester-Bradley (1949, p. 136, text-fig. 20) as 'neotype' (Plate XII, fig. 3). Dimensions: length 1·15 mm, height 0·78 mm, width 0·58 mm, length/height ratio 1·47. Locality: between Dallard's Farm and Catherine Ford, Vale of Wardour, Wiltshire. Horizon: Middle Purbeck.

Diagnosis. Carapace triangular-ovate in side view, dorsal margin convex with marked antero-dorsal angle. Rostrum large, alveolus fairly deep and extending upwards for about one-third of the height of the shell, cyathus obtuse triangular. Surface covered with coarse irregular punctations and ornamented with a number of hemispherical tubercles.

Description. Fitton (1836, p. 352) gives "Suss. 177" and "S. Wilts. 260" as the localities for *C. granulosa.* The reference on p. 177 is to material in the Mantell Collection from Tilgate Forest which has not been traced. The reference on p. 260 is to several localities including "between Dallard's Farm and Catherine Ford", and material so labelled was presented by Fitton to the Geological Society of London. Any specimen from this slab is clearly a syntype, available for designation as lectotype, and it was not necessary for Sylvester-Bradley (loc. cit. 1949) to designate a neotype. The specimen he chose is a syntype and is here confirmed as lectotype.

This species is an excellent example of the type of evolutionary change commonly found in the genus. Three trends can be recognized: (i) reduction in the number of tubercles, (ii) increase in the size of individual tubercles and (iii) reduction in the length/height ratio, i.e. increase in the relative height of the carapace. The trends are continuous and all intermediate stages can be seen. It is therefore assumed that the variations are the result of a gradual modification of the genetic constitution of a single species. But it is convenient stratigraphically to distinguish certain stages of the trends as subspecies. New species of *Cypridea* appear to have originated by mutations of a different order and there is no convincing evidence connecting any one species with a previously existing species. Taxonomic difficulties tend to obscure this fact. For example, it appears fairly obvious that *C. altissima* represents the end-product of the reduction trend seen in *C. granulosa* and therefore that *C. altissima* should be regarded as a subspecies of *C. granulosa* rather than as a species in its own right. But if the diagnosis of the species *C. granulosa* is phrased so as to include unornamented species it becomes meaningless.

The subspecies of *Cypridea* are thus not all of equal rank. For example the present writer (1967, p. 240) described the unornamented form of *C. clavata* as the subspecies *maleta* simply because at this horizon there were no other inverse species which could be confused with it, whereas although *C. pendae* Anderson (*in* Anderson and others 1967, p. 210) could be the unornamented form of *C. aculeata* it could equally well be related to *C. arenosa*, a contemporary and similar species.

Occasionally specimens of *C. peltoides* (p. 75) are found which bear a few small scattered tubercles, usually near the anterior end of the carapace. In the Upper Soft Cockle Cycle these tuberculate forms become more common. Thus *C. peltoides* could be considered as the ancestor of *C. granulosa*, but when, in

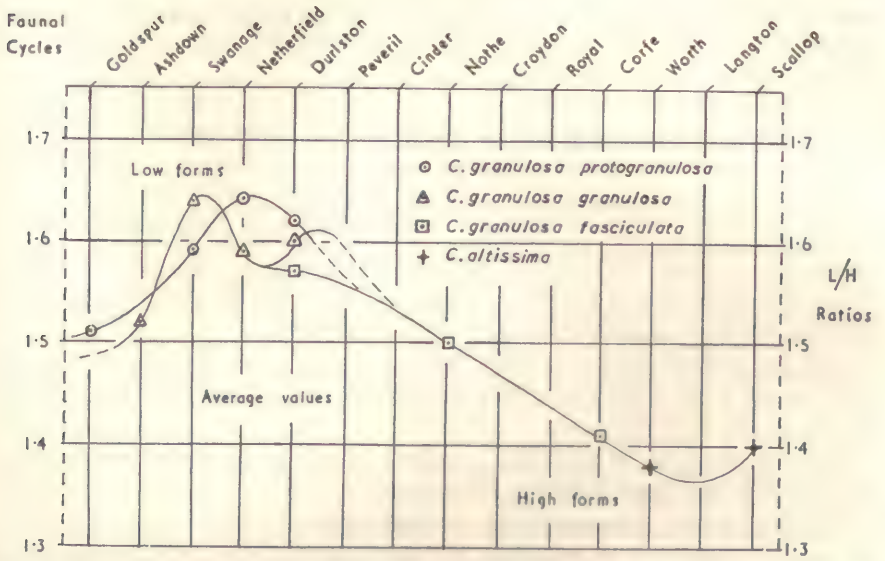


FIG. 8. Variations of length/height ratios in subspecies of *Cypridea granulosa* (J. de C. Sowerby) s.l. and in *C. altissima* Martin

the succeeding Penshurst Cycle the earliest examples of *C. granulosa* (subspecies *protogranulosa*) appear, they are forms without the characteristic velate margins of *C. peltoides* and are much more tuberculate. As many as 30 tubercles may be present, arranged in two groups, one in the anterior quarter and the other in the posterior quarter of the shell, joined by an irregular ventral row. The ornament pattern is very variable and the occurrence of any one tubercle is never more than 65 per cent. In later forms the tubercles tend to be larger and their distribution pattern more stable until in the Mountfield Cycle a new form appears (subspecies *granulosa*). In this subspecies seven tubercles have an occurrence of 80 per cent or more and there are 17 which occur in more than 50 per cent of the individuals examined. This indicates a genetic stability not seen in either of the other two subspecies.

In the Durlston Cycle many individuals show a marked reduction in ornament. In these the anterior and posterior groups are each reduced to four or five tubercles, whilst the ocular and lumbar groups and the tubercles of the ventral arc are missing (subspecies *fasciculata*). From the Royal Cycle upwards individuals occur bearing only one or two tubercles and some, the dominant form in the Langton, Scallop and Studland cycles, are without ornament though they resemble the species in every other way.

The analysis of the trend in *C. granulosa* s.l. leading to a decrease in the length/height ratio (Fig. 8) supports the suggestion that *C. altissima* may be the end result of the trend accompanied by loss of ornament. In the subspecies *protogranulosa*, *granulosa* and the early forms of *fasciculata* (those found in the Durlston Cycle) the length/height ratio oscillates about 1·6. By the Nothe Cycle the average length/height ratio in *fasciculata* has fallen to 1·5 and by the Corfe Cycle to 1·41, thus approximating closely to that of *C. altissima*, which has an average length/height ratio of 1·38 in the succeeding Worth Cycle and 1·4 in the

Scallop Cycle. Both the general appearance and the proportions of *C. altissima* are similar to those of a *C. granulosa fasciculata* without ornament (see Wolburg 1962b, p. 254).

Cypridea granulosa protogranulosa subsp. nov.

Plate XII, figs. 1–2

1963. *Cypridea* cf. *granulosa* Oertli, p. 17, pl. vi, figs. 22–3.

Holotype. GSM Mik(M) 3154001, complete carapace (Plate XII, fig. 2). Dimensions: length 1·05, height 0·7 mm, length/height ratio 1·5. Locality: Netherfield Place No. 5 Borehole, Sussex, at 907 ft 11 in to 908 ft. Horizon: Swanage Cycle, *C. g. granulosa* Zone, Middle Purbeck.

Topotype. GSM Mik(M) 3155001, left valve only (Plate XII, fig. 1). Dimensions: length 1·065 mm, height 0·69 mm, length/height ratio 1·55. Locality and horizon as for holotype.

Diagnosis. A form of *Cypridea granulosa* in which the shell surface carries relatively few and small scattered tubercles.

Description. The ornament in this subspecies is weak. The tubercles are fewer and smaller than in *C. g. granulosa* and much smaller than in *C. g. fasciculata* and they are more variable in position. Usually there are between eight and twelve tubercles arranged in two groups, one anterior, the other posterior, and the positions most commonly occupied are 8b, c, d, 11a, 1i, 1h, (percentage occurrence more than 40 per cent), 2f, 8f, 14d, 3b, 2g, 9b, 13a, b, (percentage occurrence 20 to 40 per cent).

The length/height ratio varies from 1·66 to 1·5 with an average of 1·59 which is the same as that of *C. g. granulosa.* The holotype and topotype are both more elevated forms than average.

Distribution. C. granulosa protogranulosa ranges from the *C. dunkeri* to the *C. g. fasciculata* Zone. It is first seen in the Hard Cockle Cycle, is common throughout the Mountfield to Durlston cycles, reaches its maximum development in the Goldspur Cycle and is last seen in the Nothe Cycle. It has been recovered from the Mountfield Nos. 3 and 4, Netherfield Place No. 5, Guestling Nos. 1 and 3, Penshurst (1899), Ashdown No. 1, Warlingham and Henfield No. 1 boreholes and the Goldspur Drift in the Weald; from Durlston Bay in Dorset and the Chilcomb Down No. 1 Borehole in Hampshire.

Cypridea granulosa granulosa (J. de C. Sowerby)

Plate XII, figs. 3–4

Lectotype. As for species.

Figured specimen. GSM Mik(M) 3156001, left valve only (Plate XII, fig. 4). Dimensions: length 1·15 mm, height 0·69 mm, length/height ratio 1·52. Locality: Netherfield Place No. 5 Borehole, Sussex, at 895 ft 7–8 in. Horizon: Durlston Cycle, *C. g. fasciculata* Zone, Middle Purbeck.

Description. The carapace in this subspecies has much the same proportions as *C. g. protogranulosa* but is relatively lower than *C. g. fasciculata.* The average length/height ratio is 1·59 but ranges from 1·52 to 1·64. The tubercles are larger and more numerous than in *protogranulosa*, generally smaller and always more numerous than in *fasciculata.* There are 17 tubercles with a percentage

occurrence of more than 60 per cent. The ornament pattern is more stable than in *protogranulosa*, for eight tubercles have a percentage occurrence of more than 80 per cent, namely 8b, c, d, 11a, 1h, 2f, 14d, 9b. Of these 8b, c, d, 11a, and 1h were the dominant tubercles in *protogranulosa*, whilst 14d and 9b have become more important. The addition of a ventral row of tubercles joining the anterior and posterior groups (4b, 6b, 7b, 8a, 9b) gives *C. g. granulosa* an ornament pattern quite distinct from that of either *C. g. protogranulosa* or *C. g. fasciculata*. The form figured as *Cypridea sp.* cf. *granulosa* by Wienholz (1968, pl. ii, fig. 16) bears a polar tubercle and so cannot be assigned to any of the subspecies of *C. granulosa*.

Distribution. C. g. granulosa ranges from the top of the *C. dunkeri* to the *C. g. fasciculata* Zone. The first examples occur in the Mountfield Cycle. It is common in the Goldspur to Durlston cycles, in which it has its maximum development. It has not been seen above the Nothe Cycle.

C. g. granulosa has been found in the Mountfield Nos. 3 and 4, Netherfield Place No. 5, Guestling Nos. 1 and 3, Ashdown No. 1, Henfield No. 1 and Warlingham boreholes and the Goldspur Drift in the Weald; the Chilcomb Down No. 1 and Kingsclere No. 1 boreholes in Hampshire; and at Durlston Bay in Dorset.

Cypridea granulosa fasciculata (Forbes)

Plate XII, figs. 5–7

1855. *Cypris fasciculata* Forbes, in Lyell, p. 295, fig. 337b.
1885b. *Cypridea granulosa* var. *fasciculata:* Jones, p. 340.
1940. *Cypridea mammillata* Martin, p. 292, pl. ii, figs. 18–9.
1949. *Cypridea granulosa* aff. *fasciculata:* Sylvester-Bradley, p. 136, pl. iii, figs.4–5.
1958. *Cypridea fasciculata:* Martin, p. 317.
1959. *Cypridea granulosa:* Wolburg, p. 243, pl. i, fig. 1.
1959. *Cypridea fasciculata:* Wolburg, p. 246, pl. i, fig. 3.
1962b. *Cypridea fasciculata:* Wolburg: p. 254, pl. xxix, figs. 1–6.

Neotype. GSM Mik(M) 390001 (formerly GSM (Geol. Soc. Coll.) 2679) (Plate XII, fig. 5). Dimensions: length 1·15 mm, height 0·75 mm, length/height ratio 1·53. Locality: Between Dallard's Farm and Catherine Ford, Vale of Wardour, Wiltshire. Horizon: Middle Purbeck.

Figured Specimens. GSM Mik(M) 3157001 (Plate XII, fig. 6). Dimensions: length 1·18 mm, height 0·8 mm, length/height ratio 1·48. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1819 ft. Horizon: Nothe Cycle, *C. g. fasciculata* Zone, Middle Purbeck.

GSM Mik(M) 3158001 (Plate XII, fig. 7). Dimensions: length 1·225 mm, height 0·905 mm, length/height ratio 1·37. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1805 ft. Horizon: Corfe Cycle, *C. g. fasciculata* Zone, Middle Purbeck.

Diagnosis. A high form of *C. granulosa* with relatively few large tubercles arranged in two groups, one anterior, the other posterior.

Description. Forbes's species is based on a figure without description or any details of locality. As it has not been possible to locate the original of his fig. 337b (*in* Lyell 1855) a neotype has been chosen from Fitton's original material examined by Sowerby and housed in the Geological Society's Collection (now

in the Institute of Geological Sciences Collection). The rock sample was numbered Geol. Soc. Coll. 2679 and the locality given is the same as that for the fragment from which Sylvester-Bradley chose the 'neotype' of the species. The exact horizon is in doubt but the ornament pattern suggests that the neotype of *fasciculata* is one of the earlier varieties of the subspecies and may in fact be contemporaneous with the lectotype of the species. The two forms are found together in the Durlston Cycle at the base of the Middle Purbeck. At this level the length/height ratio of *C. g. fasciculata* is not very different from that of *g. granulosa;* the average is 1·57 and the range 1·51 to 1·69.

The ornament pattern in the earlier forms of *C. g. fasciculata* is quite close to that of *C. g. granulosa* except for the absence of the ventral row of tubercles. At higher horizons the number of tubercles is less, particularly so above the Cinder Beds. Of the dominant tubercles in *granulosa* the following are retained in *fasciculata:* 8a, b, d, 1h and 9b all of which have a percentage occurrence of over 60 per cent. In most examples the ocular (11a) is absent as are 8f, 14d and the lumbar group 13a, b and c. Thus the subspecies is characterized by having two groups of tubercles, generally five or six in each, one group in the anterior quadrant of the shell and the other in the posterior quadrant. Above the Cinder Beds horizon it is usual to find individuals with only two or three tubercles in each group.

C. g. fasciculata shows a marked increase in relative height, with average length/height ratios ranging from 1·57 in the Durlston Cycle to 1·5 in the Nothe Cycle and 1·41 in the Corfe Cycle (Plate XII, fig. 7). As has been already suggested (p. 53) it is possible that *C. altissima* may be the unornamented end product of the reduction in ornament trend of *C. granulosa. C. altissima* first appears in the Worth Cycle where the length/height ratio is 1·38.

Distribution. The subspecies ranges throughout the *C. g. fasciculata* Zone. It is first seen in the Durlston Cycle, is common and characteristic of the cycles Durlston to Nothe, reaches its greatest abundance in the Durlston and Peveril cycles and dies out in the Langton Cycle. *C. g. fasciculata* has been found, sometimes very abundantly, in the Mountfield Nos. 3 and 4, Guestling No. 3, Brightling No. 27, Ashdown No. 1, Henfield No. 1, and Warlingham boreholes, and in the Goldspur Drift, all in the Weald; in the Portsdown No. 1, Chilcomb Down No. 1 and Kingsclere No. 1 boreholes in Hampshire; in the sections at Durlston Bay, Mupes Bay, Worbarrow Bay and Ridgeway in Dorset; and at Teffont in the Vale of Wardour, Wiltshire.

Cypridea inaequalis Wolburg

Plate IX, figs. 3–4

1949. *Cypridea* "*angulato/lata*" Wolburg, p. 351, text-fig. 2/2.
1959. *Cypridea inaequalis* Wolburg, p. 258, pl. ii, figs. 6, 10–2.

Holotype. SMF Xe 3290. Dimensions: length 1·03 mm, height 0·71 mm, length/height ratio 1·45. Locality: Bohrung Lastrup 8, Germany, at 1115·8–1120·8 m. Horizon: 'Wealden' 2, upper.

Figured Specimen. GSM Mik(M) 3192001. Dimensions: length 1·08 mm, height 0·725 mm, length/height ratio 1·5. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1809 ft. Horizon: Royal Cycle, *C. g. fasciculata* Zone, Middle Purbeck.

Description. This species is distinguished from the other members of the *C. propunctata* group by the disparity in the size of the valves. The left valve is considerably higher along the dorsal margin than the right. Otherwise *C. inaequalis* and *C. propunctata* (p. 79) are very similar, both with a rostrum and alveolus of medium size and a triangular cyathus. *C. amisia* (p. 53) has a smaller rostrum and alveolus but otherwise is not unlike *C. inaequalis*. Both are finely punctate species but the earlier forms of the latter as seen in the Royal Cycle (Plate IX, figs. 3–4) are coarser.

C. propunctata and *C. alta* (p. 51) are generally more inflated than *C. inaequalis* and in *C. alta* and *C. vidrana* (p. 94) the rostrum is larger. *C. andersoni* (p. 54) has a smaller rostrum and alveolus and *C. martini* (p. 72) is a much smaller form.

Distribution. In England *C. inaequalis* ranges from the *C. g. fasciculata* to the *C. setina* Zone. It first appears in the Royal Cycle and reaches its maximum development in the Bacon Cycle. Ostracods which appear to belong to this species are found in the lower part of the Upper Purbeck as high as the Brede Cycle. In Germany *C. inaequalis* ranges from the upper part of 'Wealden' 2 (?Studland Cycle) to two-thirds of the way up 'Wealden' 3 (?Mupes Cycle).

The species has been recovered from the Penshurst (1899), Penshurst (1938), Mountfield No. 3 and Ashdown No. 1 boreholes in the Weald, and from the Chilcomb Down No. 1 Borehole in Hampshire.

Cypridea lata Martin

1940. *Cypridea lata* Martin, p. 303, pl. iii, figs. 36–9.
1959. *Cypridea lata:* Wolburg, p. 252, pl. i, figs. 8, 11–2.

Holotype. SMF X/E 210, Bohrung Thören WA 1, Germany, at 776 m, top of Serpulit.

Description. In 1940 Martin figured two specimens in side view, the holotype (pl. iii, fig. 36) and a paratype (pl. iii, fig. 37) from the uppermost Serpulit of Germany. The two specimens are characterized by a triangular outline, small rostrum and alveolus and a very finely punctate, almost smooth surface, but are not identical. The paratype is lower and less acute posteriorly than the holotype. Both forms are found in England in the lower part of the Middle Purbeck (Netherfield to Cinder Beds Cycles) and may represent sexual dimorphs. Of three specimens figured here, all from the Durlston Cycle, two (Plate XV, figs. 4, 5) are close to the holotype whilst that in Plate XV, fig. 3 is near to the paratype.

The specimens figured by Wolburg (1959, pl. i, figs. 8, 11, 12) are from the lower part of 'Wealden' 1 probably at about the Cinder Beds horizon of the English succession. At higher levels (Royal to Poxwell cycles in England and the upper part of 'Wealden' 2 in Germany) the examples of *C. lata* are more triangular and a number of elevated forms appear, one of which Wolburg figured as *Cypridea sp. 1*, aff. *lata* (pl. i, fig. 10). These later forms are here named *C. lata senilis* subsp. nov.

Still higher in the sequence at the base of the Upper Purbeck, *C. lata* appears in another form. The cyathus is larger and the posterior end of the almost smooth shell is more acute. This, here named as the new subspecies *latissima*, is found, as in the case of *C. l. senilis*, in both depressed and elevated forms.

Cypridea lata lata Martin

Plate XV, figs. 3–5

Holotype. As for the species.

Figured Specimens. GSM Mik(M) 3172001, (cf. Martin 1940, pl. iii, fig. 36) (Plate XV, fig. 5). Dimensions: length 1·04 mm, height 0·68 mm, length/height ratio 1·53. Locality: Nine Acre Wood, Sussex. Horizon: Durlston Cycle, *C. g. fasciculata* Zone, Middle Purbeck.

GSM Mik(M) 3173001 (elevated variety) (Plate XV, fig. 4). Dimensions: length 1·01 mm, height 0·715 mm, length/height ratio 1·41. Locality: Milkhurst Wood, Sussex. Horizon: Durlston Cycle, *C. g. fasciculata* Zone, Middle Purbeck.

GSM Mik(M) 3174001 (depressed variety cf. Martin 1940, pl. iii, fig. 37) (Plate XV, fig. 3). Dimensions: length 1·125 mm, height 0·690 mm, length/height ratio 1·63. Locality: Goldspur Drift at 23 ft 10 in, Mountfield, Sussex. Horizon: Durlston Cycle, *C. g. fasciculata* Zone, Middle Purbeck.

Description. The specimen figured in Plate XV, fig. 5 is very close to that figured by Martin (1940) in his pl. iii, fig. 36, and represents an example of the more elevated form of the shell. That figured in Plate XV, fig. 4, represents a still more elevated form and that in Plate XV, fig. 3, is an example of the depressed form very like that figured by Martin in pl. iii, fig. 37.

Distribution. In England *C. lata lata* ranges from the top of the *C. g. granulosa* to the lower part of the *C. g. fasciculata* Zone. It first appears in the Netherfield Cycle of the Middle Purbeck, is most abundant in the Durlston Cycle but has not been recognized above the Cinder Beds Cycle. According to Wolburg (1959), in Germany it ranges through 'Wealden' 1 but is more abundant in the lower part. The present writer believes that the base of the German 'Wealden', i.e. the top of the Serpulit, is at the boundary between the *C. g. granulosa* and *C. g. fasciculata* zones, i.e. between the Netherfield and Durlston cycles. This accords with Wolburg's stratigraphical scheme (1959, pp. 227, 235).

In Sussex the subspecies has been found in the Mountfield No. 3 Borehole and in sections in the Goldspur Drift, Milkhurst Wood and Nine Acre Wood. In Dorset it occurs in Durlston Bay and in Hampshire in the Kingsclere No. 1 Borehole.

Cypridea lata senilis subsp. nov.

Plate XV, figs. 6–7, 9

1959. *Cypridea* sp. 1, aff. *lata* Martin, Wolburg, p. 253, pl. i, figs. 10 a, b.

Holotype. GSM Mik(M) 317 5001 (Plate XV, figs. 6, 7). Dimensions: length 1·025 mm, height 0·67 mm, length/height ratio 1·53. Locality: Guestling No. 1 Borehole, Sussex, at 902 ft. Horizon: Poxwell Cycle, *C. vidrana* Zone, Middle Purbeck.

Figured Specimen. GSM Mik(M) 3176001 (Plate XV, fig. 9). Dimensions: length 1·16 mm, height 0·825 mm, length/height ratio 1·41. Locality: Guestling No. 3 Borehole, Sussex, at 711 ft 1–2 in. Horizon: Studland Cycle, *Cypridea vidrana* Zone, Middle Purbeck.

Diagnosis. A subspecies of *C. lata* in which the antero-dorsal angle of the carapace is more pronounced, the posterior end less acute, the rostrum and

alveolus both slightly larger and the shell surface more finely punctate than in the nominate subspecies.

Description. The differences between *C. lata lata* and *C. lata senilis* are small but distinctive. In general more of the individuals found are elevated forms.

The holotype of *C. lata senilis* compares closely with the specimen figured by Wolburg (1959) in pl. i, figs. 10 a, b. That figured here in Plate XV, fig. 9 is a more elevated form but less so than some seen by Wolburg who gives (p. 253) the range of length/height ratios as 1·35 to 1·46.

Distribution: This subspecies appears in the Royal Cycle (*C. g. fasciculata* Zone) but is most abundant in the Scallop Cycle at the base of the *C. vidrana* Zone. It gives way to the subspecies *latissima* in the Greenwood Cycle.

In Germany it is found in the upper part of 'Wealden' 2, i.e. of Wolburg's (1959, p. 235) *altissima-bispinosa* Zone.

C. lata senilis has been found in the Warlingham, Mountfield Nos. 3 and 4, Guestling Nos. 1 and 3, Brightling No. 27 and Ashdown No. 1 boreholes and the Milkhurst Wood and Binglett's Wood Stream sections in the Weald; in the Chilcomb Down No. 1 Borehole in Hampshire; and in Durlston Bay, Dorset.

Cypridea lata latissima subsp. nov.

Plate XV, figs. 8, 10; Plate XVI, fig. 1

Holotype. GSM Mik(M) 3177001 (Plate XV, fig. 10). Dimensions: length 1·055 mm, height 0·74 mm, length/height ratio 1·43. Locality: Kingsclere No. 1 Borehole, Hampshire, at 1385 ft. Horizon: Lulworth Cycle, *C. setina* Zone, Upper Purbeck.

Topotype. GSM Mik(M) 3178001 (Plate XV, fig. 8). Dimensions: length 1·01 mm approx., height 0.74 mm, length/height ratio 1·4 approx. Locality and horizon as for holotype.

Juvenile. GSM Mik(M) 3179001 (Plate XVI, fig. 1). Dimensions: length 0·895 mm, height 0·56 mm, length/height ratio 1·6. Locality: Chilcomb Down Borehole, Hampshire, at 1765 ft. Horizon: Mupes Cycle, Upper Purbeck.

Diagnosis. A subspecies of *C. lata* in which the carapace is more triangular and more acute posteriorly, the rostrum and alveolus are smaller, the cyathus larger and in which the shell surface is almost smooth.

Description. C. lata latissima is easily distinguished from the other subspecies of *C. lata* and from any other species of *Cypridea*. The sharp slope of the postero-dorsal margin terminated by an acute-angled cyathus gives the carapace a characteristic triangular profile.

Distribution. C. lata latissima appears in the highest beds of the Middle Purbeck (Poxwell Cycle) but is most typical of the lowest beds of the Upper Purbeck (Lulworth, Mupes and Brede cycles). It has been found in the Warlingham Borehole in Surrey; the Mountfield No. 3, and Penshurst (1899) boreholes in Sussex; the Portsdown No. 1, Chilcomb Down No. 1 and Kingsclere No. 1 boreholes in Hampshire; and in Durlston Bay in Dorset. It has not so far been recorded from the 'Wealden' of Germany.

Cypridea cf. martini Wolburg

Plate X, fig. 6

1959. *Cypridea martini* Wolburg, p. 254, pl. i, fig. 9.

Holotype. SMF Xe 3278. Dimensions: length 0·73 mm, height 0·505 mm, length/height ratio 1·44. Locality: Bohrung Rühlertwist 3, Germany, at 1213 m. Horizon: middle of 'Wealden' 2.

Figured Specimen. GSM Mik(M) 3194001. Dimensions: length 0·83 mm, height 0·53 mm, length/height ratio 1·56. Locality: Warlingham Borehole, Surrey, at 1922 ft. Horizon: Brede Cycle, *C. setina* Zone, Upper Purbeck.

Description. This small form, clearly one of the *C. propunctata* group of species, is only tentatively assigned to Wolburg's *C. martini.* Though similar in size and shape it does not show the swollen furcal area illustrated by Wolburg in his pl. i, fig. 9. However, no other member of the *C. propunctata* group is as small as *C. martini* either in the English or German succession.

Distribution. C. cf. *martini* is a rare form in the English Purbeck. So far it has only been found in the Scallop and Bacon cycles (Middle Purbeck, *C. vidrana* Zone) of the Henfield No. 1 Borehole and the Milkhurst Wood section in Sussex; a horizon near the end of its range in Germany; and in the Upper Purbeck of the Warlingham Borehole.

Cypridea morula sp. nov.

Plate XIII, figs. 7–8

Holotype. GSM Mik(M) 2169001 (Plate XIII, fig. 7), left valve only. Dimensions: length 1·215 mm, height 0·9 mm, length/height ratio 1·35. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1703 ft. Horizon: Bexhill Cycle, *C. brevirostrata* Zone, Hastings Beds, Wealden.

Topotype. GSM Mik(M) 3163001 (Plate XIII, fig. 8), complete carapace. Dimensions: length 1·155 mm, height 0·81 mm, length/height ratio 1·43. Locality and horizon as for holotype.

Diagnosis. Large triangular-ovate carapace. Rostrum fairly large, alveolus fairly deep extending to about one-third the height of the shell but frequently distorted by a large tubercle immediately behind. Cyathus small, obtusely triangular, sub-terminal. Shell surface finely punctate and ornamented with large sub-hemispherical bosses. Left valve the larger.

Description. This species, which appears to be an off-shoot from the *Cypridea wicheri* stock, first appears near the base of the Wealden. In the Chilcomb Down No. 1 Borehole, in the five feet of strata between 1699 and 1704 ft, *C. morula* can be seen to take over dominance of the fauna from *C. wicheri* as follows:

Ft	*C. wicheri* %	*C. morula* %
1699	5	95
1700	20	80
1702	30	70
1703	50	50
1704	60	40

C. morula differs from *C. wicheri* in having a larger, more triangular carapace and in the ornament pattern. The bosses are generally larger and fewer, and

the posterior arc and most of the ventral arc are missing, i.e. in *C. wicheri* the tubercles are 15, 11a, 9c, 8b, 3a, 4d, 2i, e, 7c, 6c, 5c, 8c, d, e, f, 13b, c, arranged in order of importance. In *C. morula* the tubercles most frequently present are 15, 11a, 9b, c, 3a, c, and 2i.

C. morula is very like *C. verrucosa* Jones of the Grinstead Clay (Anderson *in* Anderson and others 1967, p. 221, pl. xiii, figs. 71, 74–6) and may be the ancestor of that species but is larger and with a somewhat different ornament pattern, i.e. in addition to the tubercles found in *C. morula*, *C. verrucosa* has 5c, 7c, 8c, d, e and 13b.

Distribution. C. morula is so far only known from the Battle Cycle at the top of the Purbeck Beds and Bexhill Cycle of the Wealden in the Chilcomb Down No. 1 Borehole, Hampshire.

Cypridea obliqua Wolburg

Plate XVIII, figs. 3–4

?1878a. *Cypridea valdensis*, oblong var. Jones, pp. 109–10, pl. iii, fig. 8.
?1878b. *Cypridea austeni* Jones, p. 277.
?1885b. *Cypridea austeni:* Jones, p. 316.
?1888. *Cypridea austeni:* Jones, p. 538.
1959. *Cypridea valdensis valdensis:* Wolburg, p. 282, pl. iii, figs. 5, 9.
1959. *Cypridea valdensis obliqua* Wolburg, p. 283, pl. iii, fig. 6.

Holotype. SMF Xe 3312. Dimensions: length 1·08 mm, height 0·71 mm, length/height ratio 1·52. Locality: Bohrung Rühlertwist 3, Germany, at 1056–7 m. Horizon: lower part of 'Wealden' 4.

Figured Specimens. GSM Mik(M) 3212001 (Plate XVIII, fig. 3). Dimensions: length 1·03 mm, height 0·66 mm, length/height ratio 1·56. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1764 ft. Horizon: Brede Cycle, *Cypridea setina* Zone, Upper Purbeck.

GSM Mik(M) 3213001 (Plate XVIII, fig. 4). Dimensions: length 0·985 mm, height 0·675 mm, length/height ratio 1·46. Locality and horizon as above.

Diagnosis. Carapace oblong in lateral view. Rostrum and alveolus large, cyathus small, obtuse, triangular. Shell surface finely punctate. May be ornamented with very small scattered tubercles particularly at the anterior end. Left valve the larger.

Description. This may be the form to which Jones intended to apply the name *Cypridea austeni.* According to Jones the specimen figured by Sowerby *in* Fitton (1836, pl. xxi, fig. 1) as *Cypris valdensis* was not the species figured as *Cypris faba?* by J. de C. Sowerby in 1824 (*Min. Conch.*, pl. cdlxxv), but a more oblong form for which Jones suggested the name *C. austeni.* But he included in *C. austeni:*

(i) the specimen figured by Sowerby (1836, pl. xxi, fig. 1) the original of which cannot now be traced.

(ii) the specimens figured by Jones (1862, pl. v, figs. 26–8) as *Cypridea valdensis*, from Hannover (1878b, p. 277).

(iii) specimens from the Weald Clay at Peasemarsh near Guildford in Surrey in which the alveolus was obsolete or absent. Not figured (1878b, p. 278).

(iv) an ostracod from the Shotover Sands of Oxfordshire (1878a, pl. iii, fig. 8). This is the only specimen figured by Jones as *C. austeni.* It is an indeterminable mould not recognizable as any species of *Cypridea.*

It was not until 1885 that Jones made it clear that he intended the name *C. austeni* to apply to a shell resembling *C. valdensis* but more oblong in shape.

C. austeni, being based only on an inadequate figure and some doubtful synonyms, can only be regarded as a *nomen dubium*. This is regrettable since there is an ostracod, as Jones recognized, fairly common in the Middle and Upper Purbeck in England and in the equivalent beds in Germany which bears a close resemblance to *C. valdensis* except that it is a smaller and more oblong form. It is rarely more than 1·1 mm in length whereas *C. valdensis* averages 1·24 mm in length and may be as much as 2·0 mm long.

Wolburg has described two subspecies of *C. valdensis* (1959) both of which are believed to be examples of what Jones intended by *C. austeni*. His *C. valdensis valdensis* (pl. iii, fig. 5) is very like the specimen figured here in Plate XVIII, fig. 3, and the subspecies *C. valdensis obliqua* (pl. iii, fig. 6) appears to be the form figured in Plate XVIII, fig. 4. These forms are here attributed to one species for which *C. obliqua* Wolburg is the valid name.

Both the German specimens are from the lower part of 'Wealden' 4, i.e. the upper part of the Upper Purbeck in England. The true *C. valdensis* is essentially a Weald Clay species. Anderson and Hughes (1964) have shown that the Weald Clay is represented in Germany by marine sediments, and it is therefore unlikely that *C. valdensis* occurs at all in the German 'Wealden'.

Martin (1940, p. 289) recorded *C. valdensis* from both the Thören and Rodewald boreholes, in the former from the Lower and Middle Purbeck and in the latter from the Middle Purbeck. In both cases the specimens illustrated appear to have been *C. tumescens praecursor* (see p. 89).

Distribution. In England *C. obliqua* ranges from the Croydon Cycle of the Middle Purbeck (*C. g. fasciculata* Zone) through the Upper Purbeck into the lower beds of the Wealden. This is almost exactly equivalent to the range given by Wolburg for *C. valdensis* in Germany, i.e. 'Wealden' 2 to 'Wealden' 4.

C. obliqua has been recovered from the Warlingham, Penshurst (1899) and (1938), Mountfield No. 3, Guestling No. 1, Brightling No. 27, and Ashdown No. 1 Boreholes and the Milkhurst Wood section in the Weald; in the Portsdown No. 1, Chilcomb Down No. 1 and Kingsclere No. 1 boreholes in Hampshire; and the Durlston Bay section in Dorset.

Cypridea paulsgrovensis (Anderson)

Plate XVI, fig. 6

1939. *Ulwellia paulsgrovensis* Anderson, p. 301, pl. xii, figs. 6a, b; pl. xiii, figs. 8a, b.

non 1959. *Cypridea paulsgrovensis:* Wolburg, p. 302, pl. v, figs. 5–6.

non. 1962a. *Cypridea paulsgrovensis:* Wolburg, p. 212, pl. xxxib, figs. 15–6.

1967. *Cypridea paulsgrovensis:* Anderson *in* Anderson and others, p. 218, pl. xii, fig. 53.

Lectotype. GSM Mik(M) 530001 (formerly GSM 60677). Selected by Wolburg 1959, p. 302. Dimensions: length 0·83 mm, height 0·54 mm, length/height ratio 1·54. Locality: Portsdown No. 1 Borehole, Hampshire, at 2183–5 ft. Horizon: probably base of Hastings Beds, Wealden.

Figured Specimen. GSM Mik(M) 2156001. Dimensions: length 0·815 mm, height 0·540 mm, length/height ratio 1·51. Locality: Warlingham Borehole, Surrey, at 1793 ft 6 in. Horizon: St. Leonard's Cycle, Wadhurst Clay, Wealden.

Remarks. An emended diagnosis and description of this species has been recently published (Anderson and others 1967, p. 218). A specimen from the Wadhurst Clay is figured here for comparison with the Purbeck species *C. acuta.* This is very like *C. paulsgrovensis* but the rostrum is very small and backwardly curved, the alveolus is barely visible and the cyathus is small and triangular. The specimen figured in Anderson and others 1967, pl. xii, fig. 53 is from the Kingsclere Cycle, not the Fairlight Cycle as there stated.

Distribution. C. paulsgrovensis is essentially a Wealden species, reaching its maximum development in the lower half of the Wadhurst Clay and is common in most localities. Some of the ostracods found in the Upper Purbeck may be this species but at this level it is often difficult to distinguish between *C. acuta* and *C. paulsgrovensis.*

Cypridea peltoides sp. nov.

Holotype. GSM Mik(M) 3032001, complete carapace (Plate VII, fig. 5). Dimensions: length 1·09 mm, height 0·70 mm, width 0·46 mm, length/height ratio 1·56. Locality: Mountfield No. 4 Borehole, Sussex, at 334–7 ft. Horizon: Mountfield Cycle, *Cypridea dunkeri* Zone, Lower Purbeck.

Diagnosis. Carapace triangular-ovate in lateral view with a conspicuous antero-dorsal angle, oval in dorsal and end view. Rostrum strong, alveolus well marked but relatively short, cyathus obtuse-triangular. Dorsal and ventral margins slightly velate and glabrous. Surface covered with medium-sized (0·015–0·02 mm diameter), closely-set punctations. Left valve the larger.

Description. This is one of several species which may have been recorded in the past as *Cypridea punctata* (Forbes), now *Cypridea propunctata* Sylvester-Bradley (p. 79), but which differs from that species in that the dorsal and ventral margins are swollen and glabrous. It is frequently accompanied by *Cypridea tumescens* (Anderson) (p. 88), a species which is larger, more triangular in outline and more finely punctate. Occasional specimens may bear a few, small, scattered tubercles near the anterior end.

Distribution. Forms which appear to be *C. peltoides* are found rarely in the Hard Cockle Cycle (Lower Purbeck) of the Weald but at this horizon and in the cycle above (Wardour) the velate margins are poorly developed. In the Lower Soft Cockle Cycle and above, typical examples of the species are fairly abundant reaching a maximum development at the top of the Lower Purbeck and base of the Middle Purbeck (in the Robertsbridge, Mountfield and Goldspur Cycles). By the Durlston Cycle the species has become rare though examples are occasionally found as high as the Nothe Cycle in Dorset.

In the Upper Soft Cockle Cycle high forms with a length/height ratio of about 1·38 appear (Plate VII, fig. 6) and in the Penshurst Cycle individuals are occasionally found with an even lower length/height ratio and in which the velate margins are very strongly developed, sufficiently so to distinguish them as a subspecies. This, named as *C. peltoides eurygaster*, becomes abundant at the acme of the species in the Goldspur Cycle and serves as a useful horizon marker.

Material. 2400 specimens from the Henfield No. 1, Mountfield No. 4, Netherfield Place Nos. 3 and 5, Guestling Nos. 1 and 3, Brightling No. 27 and Ashdown No. 1 boreholes and the Goldspur Drift and Nine Acre Wood sections

in Sussex; the Warlingham Borehole in Surrey; the Chilcomb Down No. 1 Borehole in Hampshire; and the Durlston Bay section in Dorset. Of these 365 were *C. peltoides eurygaster*.

Cypridea peltoides peltoides subsp. nov.

Plate VII, figs. 5–7

Holotype. As for species.

Figured Specimens. GSM Mik(M) 3317001 (elevated form) (Plate VII, fig. 6). Dimensions: length 1·08 mm, height 0·78 mm. Locality: Goldspur Drift, at 91 ft 10 in, Mountfield, Sussex. Horizon: Upper Soft Cockle Cycle, Lower Purbeck.

GSM Mik(M) 3318001 (angular form) (Plate VII, fig. 7). Dimensions: length 0·985 mm, height 0·66 mm. Locality: Mountfield No. 4 Borehole, Sussex, at 330 ft 6 in to 331 ft. Horizon: Goldspur Cycle, *C. g. granulosa* Zone, Middle Purbeck.

Cypridea peltoides eurygaster subsp. nov.

Plate VII, figs. 8–9

Holotype. GSM Mik(M) 3033001 (Plate VII, fig. 9). Dimensions: length 1·18 mm, height 0·88 mm, length/height ratio 1·34. Locality: Mountfield No. 4 Borehole, Sussex, at 328 ft 6 in to 329 ft. Horizon: Goldspur Cycle, *C. g. granulosa* Zone, Middle Purbeck.

Topotype. GSM Mik(M) 3319001 (depressed form) (Plate VII, fig. 8). Dimensions: length 1·215 mm, height 0·83 mm. Locality and horizon as for holotype.

Diagnosis. An elevated form of *C. peltoides* with strongly swollen dorsal and ventral margins. More coarsely punctate than *C. peltoides peltoides*.

Distribution. Most abundant in the Burwash Cycle. Ranges from the Upper Soft Cockle to the Goldspur Cycle in the Weald, possibly into the Ashdown Cycle in Hampshire.

Cypridea penshurstensis sp. nov.

Plate XV, fig. 1

Holotype. GSM Mik(M) 3168001, right valve only. Dimensions: length 1·06 mm, height 0·69 mm, length/height ratio 1·54. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1766 ft. Horizon: Mupes Cycle, *C. setina* Zone, Upper Purbeck.

Diagnosis. Carapace triangular-ovate in lateral view, rostrum large, alveolus well marked and extending for about one-third the height of the shell, cyathus large, triangular, terminal. Surface finely and closely punctate. Right valve the larger.

Description. C. penshurstensis resembles the Wealden *C. menevensis* (Anderson, 1939) but is larger, more triangular in outline and with a larger rostrum and cyathus. It differs from the contemporary species *C. darvelensis* (p. 57) in that the punctations are much smaller and the carapace less ovate. In *C. darvelensis* the average length/height ratio is 1·47 as against an average of 1·55 in *C. penshurstensis*. The remaining dimensions of the latter species are: average length 1·062 mm, range 1·005 to 1·165 mm; height 0·689 mm, range 0·600 to 0·755 mm.

Distribution. The species first appears in the Langton Cycle (*C. g. fasciculata* Zone) but is not very common until the Studland Cycle. It reaches its maximum in the Greenwood Cycle (*C. vidrana* Zone) where a number of high forms appear with length/height ratios as low as 1·42 (average in this Cycle 1·55). In the lower part of the Upper Purbeck (Lulworth and Mupes cycles) examples are fairly abundant but at higher levels the species is less common and most of the specimens seen are depressed with a length/height ratio of 1·66.

It is probable that some of the ostracods recorded by Wolburg (1959) from the 'Wealden' 3 of Germany as *C. menevensis* are this species, since they appear to be more coarsely punctate than is usual in the former species (see Wolburg 1959, pl. v, fig. 7).

C. penshurstensis has been found in the Warlingham, Guestling Nos. 1 and 3, Mountfield Nos. 3 and 4, Netherfield Place No. 3, Brightling No. 27, Penshurst (1899) and the Henfield No. 1 boreholes and the Binglett's Wood Stream section in the Weald; the Chilcomb Down No. 1, Kingsclere No. 1 and the Portsdown No. 1 boreholes in Hampshire; and the Durlston Bay section in Dorset.

Cypridea posticalis Jones

Plate VIII, fig. 6

1885b. *Cypridea punctata* (Forbes) var. *posticalis* Jones, p. 338, pl. viii, figs. 1–3, 6, 8.
1940. *Cypridea posticalis:* Martin, p. 307, pl. iii, fig. 44, pl. iv, figs. 46, 48–9.
1949. *Cypridea* (*Cypridea*) *posticalis:* Sylvester-Bradley, p. 145.
1968. *Cypridea posticalis:* Weinholz, pl. iii, fig. 24.

Lectotype. GSM Mik(M) 1020001 (formerly GSM 56501), original of Jones' pl. viii, fig. 8. Dimensions: length 1·085 mm, height 0·69 mm, length/height ratio 1·57. Locality: Ridgeway, Dorset. Horizon: Middle Purbeck.

Diagnosis. Carapace obovate in side view with a glabrous posterior swelling. Rostrum large, alveolus fairly deep and extending for about one-third the height of the shell. Cyathus small, obtusely triangular, almost lunate. Surface variably punctate, the punctations large and tending to be confluent in anterior and posterior areas, small or absent in central area. Left valve the larger.

Description. Jones (1885b) figured five specimens of his variety *posticalis.* One of these, that illustrated in his pl. viii, fig. 8, is here selected as lectotype. *C. posticalis*, by virtue of the glabrous posterior swelling rather like an egg pouch, differs from all other species of *Cypridea* so far known. The distribution of the punctations over the surface of the shell is uneven. The centre of the shell is often almost smooth and in the anterior and posterior areas the punctations tend to be especially large and confluent.

Distribution. The species is widely distributed but is known only from the Netherfield (*C. g. granulosa* Zone) and Durlston (*C. g. fasciculata* Zone) cycles of the Middle Purbeck. It is usually abundant in the latter. Because of this restricted vertical range *C. posticalis* is stratigraphically one of the most important species of *Cypridea.* It has been collected from the Henfield No. 1, Warlingham, Mountfield No. 3, Penshurst (1899) and Netherfield Place No. 5 boreholes and the Milkhurst Wood, Nine Acre Wood and Goldspur Drift sections in the Weald; from the Kingsclere No. 1 and Chilcomb Down No. 1

boreholes in Hampshire; from the Arreton Borehole in the Isle of Wight; from Durlston Bay, Ridgeway, Mupes Bay and the Poxwell Cutting in Dorset; and from the Vale of Wardour in Wiltshire. *C. posticalis* is recorded by Martin (1940, p. 310) as occurring in the Thören WA 1 boring in Germany at a depth of 778·5 m (Serpulit), and by Wienholz from the Serpulit of the Gardelegen 3 Borehole in E. Germany in a similar stratigraphical position to that of the English examples.

Cypridea primaeva Anderson

Plate VIII, fig. 7

1941. *Cypridea primaeva* Anderson, p. 381, pl. xviii, fig. 10.

Holotype. GSM Mik(M) 736001, complete carapace (formerly GSM 70356). Dimensions: length 0·85 mm, height 0·55 mm, width 0·33 mm, length/height ratio 1·54. Locality: Town Gardens Quarry, Swindon, Wiltshire. Horizon: *Chara* Marls, basal Purbeck Beds.

Figured Specimen. GSM Mik(M) 3153001, left valve only. Dimensions: length 0·95 mm, height 0·615 mm, length/height ratio 1·54. Locality: Netherfield Place No. 5 Borehole, Sussex, at 924 ft 8–9 in. Horizon: Goldspur Cycle, *C. g. granulosa* Zone, Middle Purbeck.

Diagnosis. A triangular-ovate, medium sized carapace. Straight, backwardly sloping dorsal margin, marked antero-dorsal angle. Rostrum rather small, alveolus very short and shallow, inclined forwards, cyathus large, triangular. Shell surface very finely punctate, sometimes almost smooth. Left valve the larger.

Description. A thin, delicate shell distinguished by the very straight dorsal margin. The only other species with a similar outline is *C. simplex* (Plate XVI, fig. 2) but this is a much smaller shell. The rostrum and alveolus are reminiscent of *C. lata* (Plate XV, figs. 3–10, Plate XVI, fig. 1) but that species is more rounded dorsally and more acute posteriorly.

Distribution. This is not a common species. It is first seen at the base of the Purbeck Beds in the Aylesbury and Swindon sections. In the Weald it first appears in the Hard Cockle Cycle but is not abundant until the Mountfield Cycle where it reaches its peak. *C. primaeva* is found but not commonly in the lower part of the Middle Purbeck. It has not been recognized above the Nothe Cycle (*C. g. fasciculata* Zone).

Material. About 200 specimens have been recovered from the Mountfield No. 4, Netherfield Place Nos. 3 and 5, Guestling Nos. 1 and 3, Brightling No. 27, Ashdown No. 1, and Penshurst (1899) boreholes, the Goldspur Drift and the Milkhurst Wood section in Sussex; from the Chilcomb Down No. 1 and Kingsclere No. 1 boreholes in Hampshire; the Durlston Bay section in Dorset and the sections at Swindon in Wiltshire; and near Aylesbury in Buckinghamshire.

The *Cypridea propunctata* Species Group
(Anderson 1962, p. 26)

In the upper part of the Middle Purbeck and in the Upper Purbeck a number of unornamented, punctate, triangular-ovate forms occur which are difficult to distinguish from each other. Most have probably been recorded as *Cypridea*

punctata (Forbes) by authors writing before 1949. In that year Sylvester-Bradley described as *Cypridea propunctata* a form which is in all probability that described by Forbes in 1855 as *Cypris punctata* and which was transferred to the genus *Cypridea* by Jones in 1885 (see Anderson 1962, p. 26).

When describing the ostracod fauna of the German 'Wealden' in 1959, Wolburg was unable to identify any of his specimens with the *C. propunctata* of Sylvester-Bradley. In this he may have been mistaken for the ostracod he described as *C. inaequalis* (niedrige Variante) (p. 259, pl. ii, fig. 11) is very like *C. propunctata*. But he was certainly correct in recognizing the fact that there were several other closely similar forms which could not be included under that name. Although the morphological distinctions between the various members of the group are trivial and tend to be obscured by variation, nevertheless the individual species can generally be recognized especially at the time of their maximum development.

The species described by Wolburg which resemble *C. propunctata* fall into two sections, those species characteristic of the upper part of the Middle Purbeck (*C. inaequalis*, *C. martini*, *C. amisia* and *C. vidrana*) and those found in the Upper Purbeck (*C. andersoni*, *C. propunctata* and *C. alta*). *C. inaequalis* is closest in appearance to *C. propunctata* but can be distinguished by a slight swelling of the dorsal margin of the left valve which makes it conspicuously higher than the right valve. This inequality, as Wolburg has shown, is variable and there are variants which approach *C. propunctata* very closely.

C. martini is the most easily distinguished species of the group on account of it being much smaller in size than the rest. The adult length is between 0·7 and 0·8 mm and the height between 0·5 and 0·6 mm.

C. alta and *C. vidrana* are elevated species with an average length/height ratio of 1·35, but there are also some elevated variants of *C. amisia*.

The rostrum and alveolus are small in *C. andersoni* and *C. amisia*, large in *C. alta* and *C. vidrana*. The cyathus varies little from species to species.

C. propunctata is a rather wide shell like *C. alta* and the punctations are somewhat coarse, as in *C. inaequalis*.

C. inaequalis may be a descendant of *C. peltoides* and probably gave rise to *C. propunctata* in the Lulworth Cycle. *C. vidrana* may have been derived from *C. amisia* in the Scallop Cycle and *C. andersoni* from *C. vidrana* in the Lulworth Cycle.

Cypridea propunctata Sylvester-Bradley

Plate IX, figs. 1–2

non 1825. *Cypris punctata* Desmarest, p. 385.
1855. ?*Cypris punctata* Forbes *in* Lyell, p. 297, fig. 339a.
1885b. *Cypridea punctata:* Jones, p. 337, pl. viii, figs. 4–5.
non 1940. *Cypridea punctata:* Martin, p. 307, pl. iv, fig. 50; pl. xii, fig. 168.
1949. *Cypridea propunctata* Sylvester-Bradley, p. 141, fig. 22.

Holotype. BM In. 39025. Dimensions (re-measured): length 0·9 mm, height 0·58 mm, width 0·4 mm, length/height ratio 1·53. Locality: Durlston Bay, Dorset. Horizon: Upper Purbeck.

Figured Specimens. GSM Mik(M) 3195001 (Plate IX, fig. 2). Dimensions: length 0·935 mm, height 0·63 mm, length/height ratio 1·48. Locality: Chilcomb

Down No. 1 Borehole, Hampshire, at 1763 ft. Horizon: Brede Cycle, *C. setina* Zone, Upper Purbeck.

GSM Mik(M) 3196001 (Plate IX, fig. 1). Dimensions: length 0·865 mm, height 0·58 mm, length/height ratio 1·49. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1768 ft. Horizon: Mupes Cycle, *C. setina* Zone, Upper Purbeck.

Description. In *C. propunctata* the rostrum, alveolus and cyathus are medium sized and the surface punctations are rather coarse. It is a more depressed form than *C. alta* (p. 51), is larger but not unlike *C. martini* (p. 72), is closest to *C. inaequalis* (p. 68) but is without the dorsal swelling of the left valve characteristic of that species. It is more coarsely punctate than *C. amisia* (p. 53), *C. alta* or *C. lata* (p. 69) and the shell is much less acute posteriorly than the last.

Since the type specimen of Forbes' *Cypris punctata* has not survived, there can be no certainty of recognizing his species, especially as his illustration bears no resemblance to any known Purbeck ostracod. Since 1885 all authors have based their identifications of *C. punctata* on Jones's figures and description of an ostracod which may or may not be that described by Forbes. In any case, as Sylvester-Bradley has shown, the name *Cypris punctata* Forbes is a junior homonym of *Cypris punctata* Desmarest.

Of the two varieties included by Jones (1885b) in *C. punctata*, i.e. *Cypris gibbosa* Forbes 1855 and *C. punctata* var. *posticalis* Jones, the first cannot now be recognized as a species of *Cypridea* and furthermore the name was preoccupied by Baird (1838). The second has been raised to specific rank by Martin (1940). In 1949 Sylvester-Bradley selected one of Jones's specimens and described it under the new name *Cypridea propunctata.*

Distribution. C. propunctata is one of the most characteristic ostracods of the English Upper Purbeck especially the lower half, Lulworth to Tisbury cycles. It is usually accompanied by *C. setina* and *C. alta* and has been recovered from the Warlingham Borehole in Surrey; the Henfield No. 1, Mountfield No. 3, Netherfield Place No. 3, Guestling No. 1 and Penshurst (1899) boreholes in Sussex; the Kingsclere No. 1 and Chilcomb Down No. 1 boreholes in Hampshire; and the Durlston Bay section in Dorset.

Cypridea sagena sp. nov.

Plate X, figs. 1–2

Holotype. GSM Mik(M) 3169001 (Plate X, fig. 1). Dimensions: length 1·03 mm, height 0·665 mm, length/height ratio 1·56. Locality: Milkhurst Wood, Sussex. Horizon: Durlston Cycle, *C. g. fasciculata* Zone, Middle Purbeck.

Figured Specimen. GSM Mik(M) 3171001 (large variety) (Plate X, fig. 2) left valve only. Dimensions: length 1·37 mm, height 0·88 mm, length/height ratio 1·56. Locality: Goldspur Drift, Mountfield, Sussex, at 46 ft 2 in. Horizon: Ashdown Cycle, *C. g. granulosa* Zone, Middle Purbeck.

Diagnosis. Carapace triangular-ovate in lateral view with a marked anterodorsal angle. Rostrum medium sized, alveolus medium sized and extending to about a quarter the height of the shell, cyathus obtuse-triangular, large. Surface covered with closely set, small, circular punctations. Left valve the larger.

Description. This species is not unlike the inverse form *C. delicatula* (p. 58) but the punctations are relatively larger, the outline is more triangular and the cyathus is triangular, not lunate. It is easily distinguished from *C. swanagensis* (p. 86) which is more coarsely punctate, has a much larger rostrum and alveolus but a smaller cyathus.

The large forms of *C. sagena* (Plate X, fig. 2) are not unlike *C. tumescens* (p. 88) except that the carapace has not the pronounced narrowing in the posterior half which is characteristic of that species.

Distribution. C. sagena ranges from the *C. dunkeri* to the *C. g. fasciculata* Zone. It is first seen in the Mountfield Cycle of the Lower Purbeck where it is scarce and relatively small with an average length of 0·985 mm, and height of 0·615 mm, length/height ratio 1·6. Some large forms appear in the Goldspur Cycle (length up to 1·37 mm, height 0·88 mm) but the maximum is reached in the Durlston Cycle where the average length is 1·172 mm and height 0·72 mm but with some individuals reaching a length of 1·44 mm and a height of 0·915 mm. The species is last seen in the Nothe Cycle where the average dimensions are length 1·00 mm, and height 0·645 mm.

C. sagena has been found in the Warlingham Borehole, Surrey; the Netherfield Place No. 5 Borehole, the Goldspur Drift and Milkhurst Wood sections in Sussex; and in the Kingsclere No. 1 Borehole in Hampshire.

Cypridea setina (Anderson)

1939. *Langtonia setina* Anderson, p. 305, pl. xii, figs. 7–8.
1949. *Cypridea* (*Pseudocypridina*) *setina:* Sylvester-Bradley, p. 146.
1962. *Cypridea setina:* Anderson, p. 23, pl. i, figs. 1–8.

Lectotype. GSM Mik(M) 535001 (formerly GSM 60682) selected by Sylvester-Bradley (1949, p. 146), complete carapace. Dimensions: length 0·95 mm, height 0·6 mm, length/height ratio 1·74. Locality: Portsdown No. 1 Borehole, Hampshire, at 2250 to 2255 ft. Horizon: Upper Purbeck.

Diagnosis. Carapace evenly ovate in outline, rostrum very small, retroverted, alveolus small almost obsolete, cyathus narrow, lunate, surface smooth, left valve the larger.

Subspecies. Six subspecies have already been described (Sylvester-Bradley 1949; Anderson 1962), distinguishable by their outline. Some of these are stratigraphically significant. Two more are now added.

Cypridea setina acerata Anderson

Plate XVII, fig. 1

1959. *Cypridea setina* (subovate variety) Wolburg, p. 296.
1962. *Cypridea* (*Pseudocypridina*) *setina acerata* Anderson, p. 25, pl. i, fig. 7.

Holotype. GSM Mik(M) 3204001 (formerly Mik(M) 477004). Dimensions: length 1·015 mm, height 0·63 mm, length/height ratio 1·6. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1710 ft. Horizon: Hastings Beds, Wealden.

Diagnosis. Carapace oval in outline, relatively low, very slightly flattened on dorsal margin. Average length/height ratio 1·64.

Description. The subspecies *acerata* and *setina* are very alike but the flattening of the dorsal margin in the former, though slight, links it with subspecies like

erumna and *rectidorsata* rather than *setina*. It is a depressed form with length/height ratios ranging from 1·55 to 1·67.

Pseudocypridina inornata Peck (1951) is very similar in outline but larger and is probably more closely related to *Cypridea laevigata* (Dunker).

Distribution. This subspecies is rare in the Upper Purbeck but is found abundantly in the lower part of the Hastings Beds of the Wealden. It is probably the subovate variety of *C. setina* recorded by Wolburg from the 'Wealden' 4 and 5 of Germany (Wolburg 1959, p. 296). Specimens have been recovered from the Henfield No. 1 Borehole in Sussex, and from the Chilcomb Down No. 1, Kingsclere No. 1, and Portsdown No. 1 boreholes in Hampshire.

Cypridea setina bellatula subsp. nov.

Plate XVII, figs. 2–3

Holotype. GSM Mik(M) 2153001, left valve only (Plate XVII, fig. 2). Dimensions: length 1·0 mm, height 0·6 mm, length/height ratio 1·67. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1700 ft. Horizon: Hastings Beds, Wealden, base of *C. paulsgrovensis* Zone.

Figured Specimen. GSM Mik(M) 3203001 (Plate XVII, fig. 3). Dimensions: length 0·935 mm, height 0·585 mm, length/height ratio 1·6. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1699 ft. Horizon: Hastings Beds, Wealden, base of *C. paulsgrovensis* Zone.

Diagnosis. Carapace oval in both lateral and dorsal view. Low, with a length/height ratio averaging 1·66.

Description. This, almost the last survivor of the *C. setina* stock, resembles *C. setina setina* but is larger and more regularly oval in outline. It is more depressed than any other subspecies of *C. setina.* The rostrum is smaller than in any other member of the group and the alveolus is barely perceptible.

Distribution. The subspecies is abundant at the base of the *C. paulsgrovensis* Zone in the Warlingham Borehole, Surrey; Chilcomb Down No. 1, and Portsdown boreholes, Hampshire.

Cypridea setina camelodes Anderson

Plate XVII, fig. 4

1962. *Cypridea* (*Pseudocypridina*) *setina camelodes* Anderson, p. 25, pl. i, fig. 6.

Holotype. GSM Mik(M) 3202001 (formerly Mik(M) 500025). Dimensions: length 0·985 mm, height 0·71 mm, length/height ratio 1·39. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1745 ft. Horizon: Tyneham Cycle, *C. setina* Zone, Upper Purbeck.

Diagnosis. An elevated form similar in shape to *C. setina rectidorsata* but with a saddle-shaped dorsal margin. Average length/height ratio 1·45.

Description. The shell is generally more elevated than in *C. setina rectidorsata* in which the length/height ratio rarely falls below 1·5.

Distribution. C. setina camelodes is only known from the Tyneham Cycle of the Upper Purbeck in the Chilcomb Down No. 1 Borehole, Hampshire, and the Warlingham Borehole, Surrey, following significantly after the last appearance of *C. setina rectidorsata.*

Cypridea setina deburghi subsp. nov.

Plate XVIII, fig. 1

Holotype. GSM Mik(M) 2152001. Dimensions: length 1·01 mm, height 0·675 mm, length/height ratio 1·5. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1729 ft. Horizon: Hastings Beds, Wealden, *Cypridea brevirostrata* Zone.

Diagnosis. Carapace almost semi-circular in lateral view, oval from above. Rostrum extremely small. No alveolus.

Description. This subspecies is an offshoot of the *C. setina* stock in which the rostrum and alveolus are virtually obsolete. In some individuals there is a slight indication of a rostrum but none possesses an alveolus so that in these cases the rostrum is only indicated by a slight concavity at the antero-ventral angle. In all other respects *C. setina deburghi* has the characters of the species, in particular resembling the subspecies *dotica.*

Distribution. This subspecies is only known from the beds immediately following on the Upper Purbeck, i.e. the *C. brevirostrata* Zone of the Wealden in the Chilcomb Down No. 1 Borehole, Hampshire.

Cypridea setina dotica Anderson

Plate XVII, figs. 5–6

1959. *Cypridea setina* (arcuate variety) Wolburg, p. 295, pl. v, fig. 17.
1962. *Cypridea* (*Pseudocypridina*) *setina dotica* Anderson, p. 25, pl. i, figs. 3–4.

Holotype. GSM Mik(M) 3311001 (formerly Mik(M) 505057) (Plate XVII, fig. 5). Dimensions: length 1·02 mm, height 0·69 mm, length/height ratio 1·48. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1751 ft. Horizon: Tisbury Cycle, Upper Purbeck.

Figured Specimen. GSM Mik(M) 3312001 (formerly Mik(M) 503065) (Plate XVII, fig. 6). Dimensions: length 0·99 mm, height 0·74 mm, length/height ratio 1·34. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1749 ft. Horizon: Durdle Cycle, Upper Purbeck.

Diagnosis. An elevated form with a smoothly curved dorsal margin which is highest in the posterior half of the shell.

Description. C. setina dotica was probably derived from the subspecies *setina* but is much more elevated than that form and the dorsal margin is more acutely curved.

Distribution. This elevated form is the characteristic subspecies in the Tisbury and Durdle cycles in the Chilcomb Down No. 1 Borehole, Hampshire.

Cypridea setina erumna Anderson

Plate XVII, fig. 7

1959. *Cypridea setina* (angulate variant) Wolburg, p. 295, pl. v, fig. 15.
1962. *Cypridea* (*Pseudocypridina*) *setina erumna* Anderson, p. 24, pl. i, fig. 5.

Holotype. GSM Mik(M) 3313001 (formerly Mik(M) 547008). Dimensions: length 0·985 mm, height 0·63 mm, length/height ratio 1·56. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1762 ft. Horizon: Brede Cycle, Upper Purbeck.

Diagnosis. A subspecies distinguished by having a straight dorsal margin inclined downwards towards the posterior. A depressed form in which the length/height averages 1·58.

Description. This subspecies is not unlike the subspecies *rectidorsata* but in the latter the straight dorsal margin is parallel to the ventral margin. The North American species *Pseudocypridina piedmonti* Roth is very like *C. s. erumna* except that the dorsal margin slopes backwards in a smooth curve without the slight postero-dorsal angle seen in the latter.

Distribution. C. setina erumna is found in the Upper Purbeck of the Chilcomb Down No. 1 Borehole, Hampshire, from the Mupes Cycle upwards, but is most abundant in the Brede Cycle.

Cypridea setina florida subsp. nov.

Plate XVII, fig. 8

1962. *Cypridea* (*Pseudocypridina*) *setina acerata* (late var.) Anderson, p. 25, pl. i, fig. 8.

Holotype. GSM Mik(M) 3199001 (formerly Mik(M) 474046) (figd. Anderson 1962, pl. i, fig. 8). Dimensions: length 1·05 mm, height 0·725 mm, length/height ratio 1·4. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1705 ft. Horizon: *C. brevirostrata* Zone, Hastings Beds, Wealden.

Topotype. GSM Mik(M) 3200001 (Plate XVII, fig. 8). Dimensions: length 1·095 mm, height 0·77 mm, length/height ratio 1·4. Locality and horizon as for holotype.

Diagnosis. Like the subspecies *acerata* but with centre of dorsal margin, especially in the left valve, swollen so as to form a projecting hump. This is an elevated form with a length/height ratio averaging 1·43.

Description. This distinctive variety was thought (Anderson 1962) to be an elevated form of the subspecies *acerata* but on further consideration it appears to have a greater affinity with the *setina* rather than with the *rectidorsata* branch of the species.

Distribution. C. setina florida is characteristic of the Bexhill and Eastbourne cycles of the Lower Wealden ('Wealden' 4 of Germany) in the Chilcomb Down No. 1 Borehole, Hampshire.

Cypridea setina rectidorsata Sylvester-Bradley

Plate XVII, fig. 9

1939. *Langtonia setina* Anderson, p. 305, pl. xii, fig. 7b.
1949. *Cypridea* (*Pseudocypridina*) *setina rectidorsata* Sylvester-Bradley, p. 147, figs. 24–5.
1949. *Cypridea valdensis* Wi 3 "*biangulata*", Wolburg, p. 351, figs. 2, 4 (*nomen nudum*).
1959. *Cypridea rectidorsata:* Wolburg, p. 293, pl. v, fig. 1.
1962. *Cypridea* (*Pseudocypridina*) *setina rectidorsata:* Anderson, p. 23, pl. i, fig. 1.

Holotype. BM In. 39180. Dimensions: length 1·05 mm, height 0·68 mm, length/height ratio 1·55. Locality: Osmington Mills, Dorset. Horizon: Upper Purbeck.

Figured Specimen. GSM Mik(M) 3314001 (formerly Mik(M) 555053). Dimensions: length 0·975 mm, height 0·63 mm, length/height ratio 1·47. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1767 ft. Horizon: Mupes Cycle, Upper Purbeck.

Diagnosis. Dorsal margin straight, almost parallel to the ventral margin.

Description. In this subspecies the middle third of the dorsal margin is straight and virtually parallel to the ventral margin. In the original description of *C. setina*, Anderson (1939) figured two specimens one of which (pl. xii, fig. 7a) was selected by Sylvester-Bradley (1949, p. 146) as the lectotype of *C. setina setina.* The other (pl. xii, fig. 7b) was included in his new subspecies *rectidorsata.*

Distribution. This is the first subspecies of the *C. setina* stock to appear, possibly in the Bacon, certainly in the Poxwell Cycle of the Middle Purbeck. It is the dominant form in the lower half of the Upper Purbeck. In the Weald it has been found in the Warlingham, Mountfield Nos. 3 and 4, Netherfield Place No. 3, Guestling No. 1, Penshurst (1899) and Henfield No. 1 boreholes.

Cypridea setina setina Anderson

Plate XVII, fig. 10

1939. *Langtonia setina* Anderson, p. 305, pl. xii, fig. 7a.
1949. *Cypridea* (*Pseudocypridina*), *setina setina:* Sylvester-Bradley, p. 146.
1959. *Cypridea setina* (ovate variety) Wolburg, p. 295, pl. v, fig. 2.
1962. *Cypridea* (*Pseudocypridina*) *setina setina*, Anderson, p. 24, pl. i, fig. 2.

Lectotype. As for species.

Figured Specimen. GSM Mik(M) 3315001 (formerly Mik(M) 550049). Dimensions: length 0·905 mm, height 0·585 mm, length/height ratio 1·55. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1764 ft. Horizon: Brede Cycle, Upper Purbeck.

Diagnosis. As for species.

Description. The lectotype is a particularly depressed form with a length/height ratio of 1·74. The average length/height ratio for the species is 1·6.

This form is distinguished by the uniform and symmetrical curve of the dorsal margin. It is evidently the ovate variety of Wolburg. In the Brede Cycle individuals like that figured here are common. They are more elevated than most earlier forms of the subspecies. In the Tyneham, Durdle and Tisbury cycles this trend continues eventually producing forms with the dorsal margin elevated in the centre which have been separated as a distinct subspecies *dotica* (Anderson 1962).

Distribution. C. setina setina is first seen in the Lulworth Cycle at the base of the Upper Purbeck, but it is most common in the upper half of the Upper Purbeck (Tisbury to Battle cycles).

In the Weald it has been recovered from the Warlingham, Mountfield No. 3, Netherfield Place No. 3, Penshurst (1899) and (1938) and Henfield No. 1 boreholes.

Cypridea simplex sp. nov.

Plate XVI, fig. 2

Holotype. GSM Mik(M) 3209001. Dimensions: length 0·72 mm, height 0·46 mm, length/height ratio 1·57. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1755 ft. Horizon: Tisbury Cycle, *C. setina* Zone, Upper Purbeck.

Diagnosis. Small triangular-ovate carapace. Rostrum very small, alveolus narrow and short and directed forwards, cyathus acute-triangular. Surface very finely punctate. Left valve the larger.

Description. This small, inconspicuous species is common at certain horizons in the Upper Purbeck and Wealden but because of its resemblance to the juveniles of several other species is difficult to determine. It is, however, consistently smaller than most species of *Cypridea*, averaging 0·7 mm in length, and the rostrum too is smaller than usual. The surface punctations are very fine so that the shell frequently appears to be smooth. The sharp triangular cyathus is distinctive. Apart from the lack of ornament *C. simplex* is very like *C. varians* (p. 90).

Distribution. C. simplex, first seen in the Upper Soft Cockle Cycle, occurs throughout the Middle and Upper Purbeck and the lower part of the Wealden but is especially abundant in the Scallop Cycle and the *Corbula* Beds above.

In the Weald *C. simplex* has been seen in the Warlingham, Mountfield Nos. 3 and 4, Netherfield Place Nos. 3 and 5, Guestling Nos. 1 and 3, Ashdown No. 1, Penshurst (1899) and Henfield No. 1 boreholes; and in the sections in the Goldspur Drift, Milkhurst Wood, Nine Acre Wood and Binglett's Wood.

Cypridea swanagensis sp. nov.

Plate VIII, figs. 4, 5

?1968. *Cypridea* cf. *binodosa:* Wienholz, pl. iii, figs. 22–3.

Holotype. GSM Mik(M) 3161001, left valve only (Plate VIII, fig. 5). Dimensions: length 1·08 mm, height 0·725 mm, length/height ratio 1·49. Locality: Milkhurst Wood, Sussex. Horizon: Durlston Cycle, *C. g. fasciculata* Zone, Middle Purbeck.

Diagnosis. Carapace triangular-ovate in side view. Rostrum large and strong, alveolus long and deep, extending almost half-way across shell, cyathus small, obtuse-triangular, almost lunate. Surface covered with medium coarse punctations, may be unornamented or with a few tubercles primarily in the lumbar area. Characteristically there is a slight swelling in the furcal area. Left valve the larger.

Description. This species may be related to *C. coelnothi* (p. 56), which it resembles in many respects, but in *C. swanagensis* the shell is sparsely tuberculate, if at all, the cyathus is smaller and the posterior swelling is distinctive. The last feature links *C. swanagensis* with *C. posticalis* (p. 77) but in the latter the swelling is more clearly defined and glabrous. *C. sagena* (p. 80) is more finely punctate and in *C. lata* (p. 69) and *C. posticalis* the punctations are less evenly distributed and the centre of each valve may be almost smooth.

In *C. binodosa* Martin (1940, p. 306) the rostrum also is swollen especially in the left valve. The form figured by Wienholz (1968) as *C.* cf. *binodosa* from the Serpulit of East Germany is more like *C. swanagensis.*

Cypridea swanagensis swanagensis subsp. nov.

Plate VIII, fig. 5

Details. As for holotype of species.

Distribution. The subspecies first appears in the Netherfield Cycle becoming abundant in the Durlston Cycle where it tends to be more coarsely punctate. It has not been recovered from higher horizons.

C. swanagensis swanagensis has been found in the Mountfield No. 3 and Netherfield Place No. 5 boreholes and the Goldspur Drift, Nine Acre Wood and Milkhurst Wood sections in Sussex; in the Chilcomb Down No. 1 Borehole in Hampshire; and the Poxwell Cutting in Dorset.

Cypridea swanagensis ornata subsp. nov.

Plate VIII, fig. 4

Holotype. GSM Mik(M) 3162001, complete carapace. Dimensions: length 0·96 mm, height 0·645 mm, length/height ratio 1·49. Locality: Milkhurst Wood, Sussex. Horizon: Durlston Cycle, *C. g. fasciculata* Zone, Middle Purbeck.

Diagnosis. As for *C. swanagensis* but with two, or more usually, three tubercles (13a, b, c) in the lumbar area. Occasionally there may be a few small inconspicuous tubercles in the antero-dorsal and postero-dorsal areas.

Distribution. Known only from the Durlston Cycle in the Milkhurst Wood section in Sussex.

Cypridea tuberculata (J. de C. Sowerby)

Cypridea tuberculata adjuncta Jones

Plate XIII, fig. 5

1885b. *Cypridea tuberculata adjuncta* Jones, p. 342, pl. viii, fig. 22.
1940. *Cypridea jonesi* Martin, p. 301, pl. ii, figs. 27–8.
1949. *Cypridea tuberculata adjuncta:* Sylvester-Bradley, p. 144, pl. iv, fig. 6.
1959. *Cypridea jonesi:* Wolburg, p. 287, pl. iv, fig. 3.

Lectotype. BM In. 39016 (Designated by Sylvester-Bradley, 1949, p. 144). Dimensions (re-measured): length 0·98 mm, height 0·63 mm, length/height ratio 1·56. Locality: Mupes Bay, Dorset. Horizon: Upper Purbeck.

Figured Specimen. GSM Mik(M) 3208001. Dimensions: 0·80 mm, height 0·475 mm, length/height ratio 1·68. Locality: Henfield No. 1 Borehole, Sussex, at 1020–25 ft. Horizon: basal Wealden (?Hastings Cycle).

Diagnosis. Carapace oblong-ovate in lateral view. Rostrum fairly large, alveolus straight and deep, cyathus small and cupate. Surface punctate and ornamented with numerous blunt conical tubercles arranged in the *C. tuberculata* pattern (Anderson *in* Anderson and others 1967, p. 203, pl. ix, fig. 2).

Description. In this subspecies the tubercles are fewer, smaller and less sharp than in *C. tuberculata* (Anderson 1967, p. 250, pl. xvii, figs. 57, 58) and the outline of the carapace is more oblong. Jones (1885b, p. 343) said that this subspecies was "longer than the typical form, less strongly beaked", but this is not generally true. Martin's species *C. jonesi* (1940) appears to be the same as *C. tuberculata adjuncta* but his illustration does not show the ornament clearly. Wolburg's figure of *C. jonesi* illustrates the ornament pattern well but shows the spines as sharper than in most English examples. In England, *C. tuberculata adjuncta* is rarely more than one millimetre in length whereas Martin's figured specimen is 1·25 mm long and Wolburg's 1·2 mm, and both are more elevated than the average English *adjuncta* with length/height ratios of 1·47 and 1·46, compared with the lectotype which is 1·56.

Distribution. C. tuberculata adjuncta is a characteristic form in the highest beds of the Purbeck where it is often very abundant, and of the basal Wealden,

especially in Dorset. In Germany it is found in the middle and upper part of 'Wealden' 4. In the Weald this subspecies is so far only known from the Tisbury and Tyneham Cycles and basal Wealden of the Henfield No. 1 Borehole.

Cypridea tuberculata langtonensis subsp. nov.

Plate XIII, fig. 4

Holotype. GSM Mik(M) 3207001. Dimensions: length 0·97 mm, height 0·645 mm, length/height ratio 1·51. Locality: Warlingham Borehole, Surrey, at 1962 ft 11 in. Horizon: Scallop Cycle, *C. vidrana* Zone, Middle Purbeck.

Diagnosis. An ovate form of *C. tuberculata.* Rostrum large, alveolus long and deep, cyathus small, cupate. Shell surface covered with moderately sized punctations and ornamented with numerous strong conical tubercles arranged in the *C. tuberculata* pattern.

Description. This is the earliest known subspecies of *C. tuberculata.* It is ovate like *C. t. adjuncta* but the tubercles are larger, sharper and more numerous. It can be distinguished from *C. tuberculata tuberculata* by its ovate outline, finer punctations and slightly less dense tuberculate ornament. There is also a subtle difference in the ornament pattern in that the tubercles tend to be larger in the posterior half of the shell, whereas in *tuberculata tuberculata* they are more uniform in size.

Distribution. This rare form is known only from the Scallop Cycle of the Middle Purbeck. It has been found in the Warlingham Borehole in Surrey and in the Guestling No. 1 Borehole in Sussex. Jones (1885b, p. 343) records a *C. tuberculata* from the Middle Purbeck of Durlston Bay but subsequent collecting has not yet confirmed this.

Cypridea tumescens (Anderson)

Plate VIII, figs. 1–3

1939. *Cyamocypris tumescens* Anderson, p. 306, pl. xiii, figs. 4, 7.
1963. *Cypridea valdensis praecursor* Oertli, p. 16, pl. iii, figs. 13–9.
1968. *Cypridea tumescens praecursor:* Wienholz, pl. ii, figs. 14–5, *non* fig. 13.

Holotype. GSM Mik(M) 540001 (formerly GSM 60687), complete carapace (Plate VIII, fig. 3). Dimensions: length 1·39 mm, height 0·79 mm, width 0·53 mm, length/height ratio 1·76. Locality: Friar Waddon, Upwey, Dorset. Horizon: Durlston Cycle, *C. g. fasciculata* Zone, Middle Purbeck.

Diagnosis. Elongate triangular-ovate in lateral view, oval in dorsal and end views. Rostrum large with well-developed fringe, alveolus long and fairly deep, cyathus large, obtuse, triangular. Slightly velate dorsally. Surface finely punctate. Left valve the larger.

Description. This is a large species bearing a superficial resemblance to *Cypridea valdensis* of the Wealden, but the latter is more triangular in outline and the punctations are finer. There is a large stratigraphical gap between the last appearance of *C. tumescens* and the first appearance of *C. valdensis.*

When the species first appears in the uppermost Portland Beds at Swindon and in Buckinghamshire it is not unlike a large form of *C. peltoides* (p. 75). It is nowhere very abundant until the Hard Cockle Cycle but from then on it is common up to the base of the Middle Purbeck. By the Mountfield Cycle the punctations have become coarser and the carapace is smaller with a less pro-

nounced dorsal swelling (*C. t. praecursor*, Plate VIII, fig. 2). At still higher horizons (Netherfield, Durlston and Peveril cycles) the commonest form of the species is represented by the holotype though the dorsal, anterior and posterior swellings are not always so conspicuous.

Distribution. C. tumescens s.l. is a fairly common form throughout the Lower and Middle Purbeck up to the Cinder Beds horizon. None have been recognized above the Croydon Cycle.

Material. 1594 specimens have been collected from the Mountfield Nos. 3 and 4, Netherfield Place Nos. 3 and 5, Guestling Nos. 1 and 3, Brightling No. 27, Pevensey (1899), Henfield No. 1, Netherfield (Sub-Wealden) and Ashdown No. 1 boreholes and the Goldspur Drift in Sussex; from the Warlingham Borehole in Surrey; the Kingsclere No. 1 and Chilcomb Down No. 1 boreholes in Hampshire; from Swindon in Wiltshire; the Aylesbury area in Buckinghamshire; and from Durlston Bay, Friar Waddon and Ridgeway in Dorset.

Three stratigraphically significant subspecies have been recognized.

Cypridea tumescens acrobeles subsp. nov.

Plate VIII, fig. 1

1963. *Cypridea* aff. *valdensis praecursor* Oertli, pl. iv, fig. 1.
1966b. *Cypridea tumescens praecursor:* Barker, p. 471, pl. vii, fig. 4.
?1968. *Cypridea tumescens praecursor:* Wienholz, pl. iii, fig. 14.

Holotype. GSM Mik(M) 3150001, complete carapace. Dimensions: length 1·115 mm, height 0·755 mm, length/height ratio 1·53. Locality: Mountfield No. 4 Borehole, Sussex, at 418 ft. Horizon: Hard Cockle Cycle, *C. dunkeri* Zone, Lower Purbeck.

Diagnosis. A form of *C. tumescens* in which the postero-dorsal margin slopes sharply downwards and backwards from the hinge and in which the dorsal and ventral swellings are well marked. The rostral fringe and cyathus are smaller than in *C. tumescens tumescens.*

Distribution. This subspecies makes its first appearance in the uppermost part of the Portland Stone at Swindon and in Buckinghamshire but does not seem to have spread into the Weald or Dorset until considerably later, unless the specimens found in the Ridgeway and Swindon cycles of the Henfield No. 1 Borehole are *in situ.* In the Upwey Cycle of the Goldspur Drift section at Mountfield in Sussex a few specimens were found which may be *C. tumescens acrobeles.* Typical examples, however, occur in the succeeding Hard Cockle Cycle both in Dorset and the Weald. The subspecies reaches its greatest abundance in the Hard Cockle and Wardour cycles where it may represent up to 83 per cent of the fauna. In the Lower Soft Cockle Cycle, where it may represent up to 42 per cent of the fauna, it includes a number of unusually large examples. In the Upper Soft Cockle, Penshurst and Ringstead cycles the subspecies is not very abundant nor is the form very distinctive, and by the Robertsbridge Cycle it has been replaced by the subspecies *praecursor.*

Cypridea tumescens praecursor Oertli

Plate VIII, fig. 2

1940. *Cypridea valdensis:* Martin, p. 288, pl. i, figs. 1–4.
1963. *Cypridea valdensis praecursor* Oertli, pl. iii, figs. 13, *non* figs. 16–9, *nec* pl. iv, figs. 20–1.
1968. *Cypridea tumescens praecursor:* Wienholz, pl. iii, fig. 15.

Holotype. SMF No. X/E 295. Selected by Oertli from Martin's specimens of *C. valdensis.*

Figured Specimen. GSM Mik(M) 3320001. Dimensions: length 1·14 mm, height 0·73 mm. Locality: Mountfield No. 4 Borehole, Sussex, at 329 ft 6 in to 330 ft. Horizon: Goldspur Cycle, *C. g. granulosa* Zone, Middle Purbeck.

Description. This appears to be the form of *C. tumescens* especially characteristic of the basal Middle Purbeck (Goldspur Cycle) but it is also found in the upper beds of the Lower Purbeck. The other specimens figured by Oertli from the Lower Purbeck resemble more closely the subspecies *acrobeles*, especially his pl. iv, fig. 1 named as *C.* aff. *valdensis praecursor*, as does that figured by Wienholz, pl. iii, fig. 14.

Distribution. In the Burwash, Mountfield and Goldspur cycles, *C. tumescens* is abundant but this time the typical form is more evenly rounded dorsally, and less narrowed posteriorly, i.e. the subspecies *praecursor*. In the succeeding Ashdown Cycle some individuals are very large but the subspecies is much less abundant. Identification is made more difficult by the presence of *Cypridea sagena* (p. 80), which is similar to *C. tumescens* but in which the carapace is smaller, relatively higher, more finely punctate, and the cyathus more terminal.

Cypridea tumescens tumescens (Anderson)

Plate VIII, fig. 3

Details. As for holotype of species.

Distribution. This subspecies is only found in any abundance in the Durlston Cycle. It is especially characteristic of the Middle Purbeck Chert Bed in which many individuals show the swellings of the left valve in an exaggerated form.

C. tumescens tumescens first appears in the Swanage Cycle and is last seen in the Croydon Cycle.

Cypridea varians sp. nov.

Plate XIII, fig. 2

Holotype. GSM Mik(M) 3210001. Dimensions: length 0·77 mm, height 0·54 mm, length/height ratio 1·43. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1732 ft. Horizon: Battle Cycle, *C. setina* Zone, Upper Purbeck.

Diagnosis. Small triangular-ovate carapace. Rostrum and alveolus very small, cyathus small, acutely triangular and terminal. Surface very finely punctate and ornamented with several medium-sized conical tubercles of which the three lumbar tubercles (13a, b, c) are the most constant.

Description. This form is similar in outline to *C. simplex* (Plate XVI, fig. 2) but differs in that the shell is tuberculate. The ornament pattern is very variable. In the majority the only tubercles are the lumbar three (13a, b, c), but there are sometimes only two. In other cases the lumbar three are accompanied by the polar tubercle (15), particularly in the Upper Purbeck, and/or one or two oculars. In size *C. varians* averages 0·71 mm in length, and 0·47 mm in height with a length/height ratio of 1·52. But there is an associated group of smaller forms with the average dimensions length 0·55 mm, height 0·35 mm, length/height ratio 1·57. In these the tubercles are more abundant and the pattern even more variable. They may represent a prematuration moult but juveniles are not very commonly associated with adults in the genus *Cypridea.*

Distribution. C. varians, first seen in the Mountfield Cycle at the top of the Lower Purbeck, is a widely distributed species in the Middle and Upper Purbeck and lower part of the Wealden but is most abundant in the Battle Cycle. In the Weald *C. varians* has been found in the Warlingham, Mountfield No. 3, Guestling Nos. 1 and 3 boreholes and in the Goldspur Drift, Milkhurst Wood and Nine Acre Wood sections.

Cypridea ventrosa Jones

Plate XIII, fig. 6

1885b. *Cypridea ventrosa* and var. *globosa* Jones, p. 340, pl. viii, figs. 25–6.

Holotype. BM I. 1661 (T. R. Jones Collection 40/2). Dimensions: length 1·0 mm. Locality: Durlston Bay, Dorset. Horizon: Upper Purbeck.

Figured Specimen. GSM Mik(M) 3205001 (formerly GSM 88490). Dimensions: length 1·04 mm, height 0·77 mm, length/height ratio 1·35. Locality: Peveril Point, Swanage, Dorset. Horizon: Upper Purbeck.

Diagnosis. Carapace ovoid in outline but with a swollen antero-dorsal angle and with a glabrous swelling or velum along the ventral margin. Rostrum large and strong; alveolus long, narrow and curved; cyathus small, obtuse, triangular. Shell surface smooth, ornamented with a number of rounded tubercles. Left valve the larger.

Description. Jones's original figure gives a reasonably good idea of this species except that the pre-alveolar ridge is somewhat exaggerated and the alveolus itself is not shown. Even so in some specimens the tubercles on the rostrum coalesce so as to form an irregular ridge along the anterior margin of the alveolus.

This distinctive species cannot easily be confused with any other though there is a superficial resemblance to an earlier form, *C. peltoides eurygaster* (Plate VII, fig. 9).

The ornament is variable but the polar tubercle (15) and the three lumbar tubercles (13a, b, c) are present in most examples. Some individuals, Jones's variety *globosa*, are virtually unornamented.

Distribution. Jones records this species from both the Middle and Upper Purbeck but later search has not substantiated this. The majority of the specimens in the Collection of the Institute of Geological Sciences were collected many years ago from Peveril Point, Swanage, Dorset, it is suspected from beds not now exposed. The only other occurrence known to the author is from the Mupes Cycle in the Kingsclere Borehole in Hampshire. It is possible that Jones confused *C. ventrosa* with *C. peltoides eurygaster* and that his references to the occurrences of *C. ventrosa* in the Middle Purbeck (p. 323) really refer to the latter species. The latest known examples of *C. peltoides eurygaster* are from the Goldspur Cycle. The earliest specimen of *C. ventrosa* is from the Mupes Cycle.

Jones (1885b, p. 322) recorded *C. ventrosa* from Damon's Bed 84 in the Upper Purbeck, i.e. from the Brede Cycle, in Durlston Bay. The Institute of Geological Sciences collections include specimens from the Durdle Cycle of Durlston Bay and from Peveril Point, Swanage, probably from the Tyneham and Battle cycles. This species has not yet been recorded from the Purbeck of the Weald.

EXPLANATION OF TEXT-FIGURE 9

A. **Purbeck forms.** Nos. 23 to 43 are all from the Upper Purbeck, Mupes to Battle cycles. Where the ventral arc is present there is always an area immediately below the polar tubercle not occupied by a tubercle. The three ocular tubercles are close together and may even be fused.

(i) *C. wicheri croesi.* This subspecies carries the central type of ornament pattern consisting of the polar tubercle, an ocular and a lumbar group, ventral and furcal arcs but there is much variation, and it is unusual to find two individuals with exactly the same pattern. Nos. 23–27 and 29–31 are typical examples but many have reduced ornament in which the furcal arc is missing, viz. 28, 32, 35, 36, 38–41, or in which the ventral arc is much reduced as in no. 34.

(ii) *C. wicheri wicki.* Characteristically the polar tubercle (15) and at least one of the lumbar group (13) are present. In Purbeck examples part of the ventral arc is usually present, viz. 33, 37, 42.

(iii) *C. wicheri torosa.* Generally the polar tubercle is the only ornament. But in Purbeck examples a few small tubercles are usually found in the ventral arc as in no. 43.

B. **Wealden forms.** Nos. 1 to 20 are all from the Bexhill Cycle at the base of the Hastings Beds. The tubercles of the ventral arc, when present, are evenly spaced without a central gap.

(i) *C. wicheri croesi.* The ornament pattern, as in no. 22, is much more stable than in the Purbeck and the majority of individuals conform to this pattern. There are a few forms with reduced ornament, e.g. 21 in which the lumbar tubercles are missing and 14, 19, 20 in which the furcal arc is missing.

(ii) *C. wicheri veronae.* Characteristically the ornament pattern consists of the polar (15), some of the ocular group (11) and three (sometimes four) tubercles of the ventral arc. There are no tubercles in the furcal arc, viz. nos. 15–18.

(iii) *C. wicheri wicheri.* Generally only the polar and tubercles of the ocular group are present, viz. no. 11, but one or two tubercles of the ventral or furcal arcs may be present as in nos. 12, 13.

(iv) *C. wicheri wicki.* As in no. 9 the ornament usually consists of the polar tubercle and one of the lumbar group (13). The form with small tubercles in the ocular area, no. 10, may be a variant of either this subspecies or of *C. wicheri wicheri.*

(v) *C. wicheri torosa.* In Wealden examples, although the majority of individuals bear only the polar tubercle as in no. 2, some are found with a few tubercles in the ventral arc also, viz. nos. 3–8.

(vi) *C. wicheri isabellae.* A subspecies without ornament as no. 1.

FIG. 9. Diagram illustrating variations in the tubercular ornament of the ostracod *Cypridea wicheri* Wolburg

Cypridea vidrana Wolburg

Plate X, figs. 3–4

1959. *Cypridea vidrana* Wolburg, p. 250, pl. i, fig. 6.

Holotype. SMF Xe 3271. Dimensions: length 1·10 mm, height 0·79 mm, length/height ratio 1·4. Locality: Bohrung Scheerhorn 87, Germany, at 1157 m. Horizon: Upper part of 'Wealden' 2.

Figured Specimens. GSM Mik(M) 3180001 (Plate X, fig. 4). Dimensions: length 1·115 mm, height 0·775 mm, length/height ratio 1·44. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1791 ft. Horizon: Scallop Cycle, *C. vidrana* Zone, Middle Purbeck.

GSM Mik(M) 3181001 (Plate X, fig. 3). Dimensions: length 1·08 mm, height 0·755 mm, length/height ratio 1·44. Locality: Mountfield No. 3 Borehole, Sussex, at 286 ft 6 in. Horizon: Scallop Cycle, *C. vidrana* Zone, Middle Purbeck.

Description. The specimen from Mountfield No. 3 Borehole figured in Plate X, fig. 3 is very close to the holotype. That from the Chilcomb Down No. 1 Borehole (Plate X, fig. 4) has a more strongly developed antero-dorsal angle.

This is a difficult species to identify. On the one hand it approaches *C. altissima* (p. 52) but has a more robust rostrum and a more obtuse cyathus. On the other hand it resembles *C. alta* (p. 51) except that it has a smaller rostrum and alveolus and the carapace is more ovate in outline. Though these differences are small, individuals resembling the holotype are fairly common in the Scallop and Studland cycles which are here equated with the upper part of 'Wealden' 2 in the German succession, and the species appears to be characteristic of this horizon.

Distribution. C. vidrana ranges from the top of the *C. g. fasciculata* Zone through the whole of the *C. vidrana* Zone, i.e. from the Langton Cycle to the Greenwood Cycle. It has been found in the Warlingham, Mountfield No. 3, Guestling No. 1, Ashdown No. 1, Brightling No. 27 and Henfield No. 1 boreholes and in the Milkhurst Wood and Binglett's Wood Stream sections in the Weald; in the Chilcomb Down No. 1 Borehole in Hampshire; and the Durlston Bay section in Dorset.

Cypridea wicheri Wolburg

Text-fig. 9

1939. *Cypridea verrucosa:* Anderson, p. 299, pl. xii, fig. 3 (*non* Jones).
1940. *Cypridea* (630) Wicher, p. 268–9, pl. ii, fig. 9.
1949. *Cypridea* "*wicheri*" Wolburg, p. 352 (*nomen nudum*).
1959. *Cypridea wicheri* Wolburg, p. 288, pl. iv, figs. 4–5, 11.

Holotype. SMF Xe 3322. Complete carapace. Dimensions: length 1·05 mm, height 0·68 mm, width 0·65 mm, length/height ratio 1·55. Locality: Bohrung Bookholt No. 1, Germany, at 838 m. Horizon: lower part of 'Wealden' 5.

Amended diagnosis. A triangular-ovate carapace. Rostrum large, alveolus deep and extending to about one-third of the height of the shell, cyathus obtusely triangular, medium sized. Surface evenly punctate and usually ornamented with hemispherical bosses.

Description. In his original diagnosis Wolburg included the words "mit einer Warze dicht hinter der Mitte jeder Klappe, der sich noch eine zweite, kleinere Warze vor und oberhalb der Klappenmitte zugesellen kann". This unduly

restricts the name *C. wicheri* to forms bearing only two tubercles and Wolburg himself figured (pl. iv, fig. 5) a form with four tubercles which he called a "knoten–reiche Variante". British examples of the species show great variation in ornament ranging from rare forms without tubercles to the more common ones with from six to a dozen tubercles.

In 1939 Anderson mistakenly figured a specimen of *C. wicheri* as *C. verrucosa* Jones. At that time the type specimen of *C. verrucosa* was not known nor was it realized that it was essentially a Grinstead Clay form which did not occur in either the Upper Purbeck or the basal Wealden. Though *C. verrucosa* may well be a descendent of *C. wicheri*, the two species are easily distinguishable (see Anderson *in* Anderson and others 1967, p. 221, pl. xiii, figs. 71, 74–6).

The form described by Wolburg (1959, p. 266, pl. iii, figs. 3–4) as *Cypridea alta wicki* is believed to be one of the many varieties of *C. wicheri* rather than to be related to *C. alta* Wolburg. In the Bexhill Cycle of the basal Wealden shells with the ornament pattern shown by Wolburg (1959, pl. 3) in both figs. 3 and 4 are found together with other variants of *C. wicheri.*

The earliest forms of the species from the lowest beds of the Upper Purbeck (Lulworth Cycle) have very few tubercles but at higher levels the tubercles become more numerous and larger. The acme of the species is reached in the basal beds of the Wealden where the tubercles are usually very much larger and the ornament pattern more stable. Stratigraphically it is convenient to recognize a number of stages in the development of the ornament pattern. The more distinctive of these have here been described as subspecies though it must be emphasized that intergrading is complete. For example, in the Lulworth Cycle the majority of individuals have two tubercles or less. In the Mupes and Brede cycles, though several tubercles are usually present, three (15, 11a and 13b) predominate and give the shell a characteristic trispinose appearance. In the Tyneham and Battle cycles the characteristic appearance is given by the predominance of five tubercles, i.e. 15, 11a, 9c, 7c, and 6c, whereas the common form in the Bexhill Cycle has an ornament pattern primarily composed of sixteen tubercles, i.e. 15, 11a, 6c, 7c, 9c, 5c, 8b, c, d, e, 13b, c, 4d, 3b, d, 2c.

Distribution. Cypridea wicheri ranges throughout the Upper Purbeck but is most abundant and characteristic of the uppermost cycle (Battle) and of the lowest beds of the Wealden especially the Bexhill Cycle. It has a wide distribution occurring in the Mountfield No. 3, Penshurst (1899), and Henfield No. 1 boreholes in Sussex; the Warlingham Borehole in Surrey; the Chilcomb Down No. 1, Portsdown No. 1 and Kingsclere No. 1 boreholes in Hampshire; and the Durlston Bay section in Dorset. It occurs in the 'Wealden' of North Germany at much the same horizon as that of the maximum development of the species in England.

Cypridea wicheri isabellae subsp. nov.

Plate XIV, fig. 1; Text-fig. 9, no. 1

Holotype. GSM Mik(M) 2166001. Dimensions: length 0·95 mm, height 0·61 mm, length/height ratio 1·56. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1701 ft. Horizon: Bexhill Cycle, *C. brevirostrata* Zone, Hastings Beds, Wealden.

Diagnosis. A form of *C. wicheri* without tubercles.

Description. It is difficult to establish without any doubt the existence of unornamented forms of an ornamented species, but a number of individuals occur which resemble *C. wicheri* in every detail except that there are no tubercles. These are more abundant in the earliest assemblages, i.e. in the Lulworth Cycle of the Upper Purbeck, and at a late stage in the development of the species in the Bexhill Cycle of the Wealden. In the Lulworth Cycle 30 per cent of the individuals seen belonged to this subspecies.

Cypridea wicheri torosa subsp. nov.

Plate XIV, figs. 2–3; Text-fig. 9, nos. 2–8, 43

1959. *Cypridea alta wicki* Wolburg, p. 266, pl. iii, fig. 4 only.

Holotype. SMF Xe 3305. Dimensions: length 1·23 mm, height 0·91 mm, length/height ratio 1·35. Locality: Bohrung Georgsdorf 279 W, Germany, at 751·65 m. Horizon: lowest part of 'Wealden' 4.

Figured Specimens. GSM Mik(M) 2165001 (Plate XIV, fig. 2). Dimensions: length 0·95 mm, height 0·61 mm, length/height ratio 1·56. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1701 ft. Horizon: Bexhill Cycle, *C. brevirostrata* Zone, Hastings Beds, Wealden.

GSM Mik(M) 3164001 (Plate XIV, fig. 3). Dimensions: length 1·05 mm, height 0·675 mm, length/height ratio 1·56. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1702 ft. Horizon: Bexhill Cycle, *C. brevirostrata* Zone, Hastings Beds, Wealden.

Diagnosis. A form of *C. wicheri* with a single sub-central tubercle (15) on each valve, sometimes with small tubercles in the ventral arc.

Description. In 1959, Wolburg figured two examples of his subspecies *Cypridea alta wicki*, one with two tubercles (15 and 13b) and another with only the polar tubercle (15). It is believed that both of these are more closely related to *C. wicheri* than to *C. alta* (p. 51). The monotuberculate variety is designated as the holotype of the new subspecies *torosa* whilst the bituberculate form remains as the holotype of the subspecies *wicki.*

Though close to that figured by Wolburg (1959, pl. iii, fig. 4) the specimens figured here (Plate XIV, figs. 2–3) have a higher length/height ratio (1·56) and in fact no specimens have been seen in the English material with a length/height ratio approaching that of the holotype (1·35).

The subspecies *C. wicheri torosa* represents 20 per cent of the individuals of the species seen in the Lulworth Cycle but it is less abundant at higher levels until the Bexhill Cycle where it represents 14 per cent of the species.

Cypridea wicheri wicki Wolburg

Plate XIV, figs, 4, 6; Text-fig. 9, nos. 9, 10, 33, 37, 42

1959. *Cypridea alta wicki* Wolburg, p. 266, pl. iii, fig. 3 only.

Holotype. SMF Xe 3304. Dimensions: length 1·22 mm, height 0·82 mm, length/height ratio 1·48. Locality: Bohrung Lathen 8, Germany, at 1127·8–1130·9 m. Horizon: lower part of 'Wealden' 4.

Figured Specimens. GSM Mik(M) 3165001 (Plate XIV, fig. 4). Dimensions: length 0·97 mm, height 0·645 mm, length/height ratio 1·5. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1704 ft. Horizon: Bexhill Cycle, *C. brevirostrata* Zone, Hastings Beds, Wealden.

GSM Mik(M) 3302001 (Plate XIV, fig. 6). Dimensions: length 0·93 mm, height 0·615 mm, length/height ratio 1·52. Locality: Warlingham Borehole, Surrey, at 1929 ft 6 in. Horizon: Mupes Cycle, Upper Purbeck.

Diagnosis. A form of *Cypridea wicheri* generally bearing two tubercles only, i.e. the polar (15) and one of the lumbar group (13b) but some of the ventral arc and, more rarely, of the furcal arc may be present.

Description. The specimen figured in Plate XIV, fig. 4, appears to be very close to the type.

Distribution. The subspecies is most common in the lower part of the Upper Purbeck accounting for 20 per cent of the species in the Lulworth Cycle. In the Bexhill Cycle in the basal Wealden it represents only 2 per cent.

In the Weald *C. wicheri wicki* has been found in the Mountfield No. 3 Borehole.

Cypridea wicheri wicheri Wolburg

Plate XIV, fig. 5; Text-fig. 9, nos. 11–13

1959. *Cypridea wicheri* Wolburg, p. 288, pl. iv, fig. 4 only.

Holotype. As for species.

Figured Specimen. GSM Mik(M) 3166001. Dimensions: length 0·97 mm, height 0·63 mm, length/height ratio 1·53. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1700 ft. Horizon: Bexhill Cycle, *C. brevirostrata* Zone, Hastings Beds, Wealden.

Diagnosis. A form of *C. wicheri* generally with two tubercles only, the polar (15) and one of the ocular group (11a), but some tubercles of the ventral and/or furcal arcs may also be present.

Description. Wolburg (1959) figured two specimens as *C. wicheri;* the holotype in which only two tubercles are present in each valve, a large polar and a smaller tubercle anterior to it in the ocular area, and another form with four tubercles which may belong to the new subspecies *veronae.*

Distribution. C. wicheri wicheri was found in the Guestling No. 1 Borehole, Sussex and in the Chilcomb Down No. 1 Borehole, Hampshire.

Cypridea wicheri veronae subsp. nov.

Plate XIV, figs. 7–8, 10; Text-fig. 9, nos. 15–18

Holotype. GSM Mik(M) 2162001 (Plate XIV, fig. 8). Dimensions: length 0·96 mm, height 0·615 mm, length/height ratio 1·56. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1704 ft. Horizon: Bexhill Cycle, *C. brevirostrata* Zone, Hastings Beds, Wealden.

Topotypes. GSM Mik(M) 2161001 (Plate XIV, fig. 10). Dimensions: length 1·01 mm, height 0·63 mm, length/height ratio 1·6. Locality and horizon as for holotype.

GSM Mik(M) 3303001 (Plate XIV, fig. 7). Dimensions: length 1·01 mm, height 0·68 mm, length/height ratio 1·49. Locality and horizon as for holotype.

Diagnosis. A form of *C. wicheri* with an ornament pattern which generally consists of the polar tubercle (15), the ocular (11a), and three tubercles in the ventral arc (6c, 7c, 9c), but other, usually smaller tubercles, may be present.

Distribution. C. wicheri veronae has not yet been seen in the Lulworth Cycle but in the succeeding Mupes Cycle 24 per cent of the individuals of the species are of this subspecies and in the Brede Cycle above it is the dominant form (67 per cent). Later it becomes less common and in the Bexhill Cycle *veronae* represents only 20 per cent of the species. Some individuals of the subspecies have tubercles in the lumbar area (Plate XIV, fig. 10) or in the post-alveolar area (Plate XIV, fig. 8) but these are usually small. In the Weald *C. wicheri veronae* was found in the Warlingham and Mountfield No. 3 boreholes.

Cypridea wicheri croesi subsp. nov.

Plate XIV, fig. 9; Text-fig. 9, nos. 14, 19–32, 34–36, 38–41

Holotype. GSM Mik(M) 2160001. Dimensions: length 0·97 mm, height 0·66 mm, length/height ratio 1·47. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1704 ft. Horizon: Bexhill Cycle, *C. brevirostrata* Zone, Hastings Beds, Wealden.

Diagnosis. A form of *C. wicheri* in which the carapace is ornamented with many large hemispherical bosses, the more dominant ones being: the polar (15), an ocular group (11a, 3c, 4d), a lumbar group (13a, b, c), a ventral arc (5c, 6c, 7c, 9c) and a furcal arc (8b, c, d, e).

Description. This is the commonest subspecies of *C. wicheri.* In the earlier examples, in the Lulworth and Mupes cycles, the ornament pattern is variable but there are certain characteristic features, e.g. the ocular group is generally made up of three tubercles arranged in an oblique row, the tubercles of the ventral row are in two groups of two with a distinct gap between 6c and 7c as if a tubercle were missing, and there are usually two tubercles on the rostrum. In the Brede Cycle the ornament pattern is similar except that the tubercles of the ocular group are arranged in a very acute triangle. The Wealden forms are easily distinguished. In the Bexhill Cycle the ornament pattern is very stable. The polar tubercle is very large and the tubercles of the ocular group are large and arranged in a more or less equilateral triangle. The tubercles of the ventral arc are evenly spaced without the median gap which is so characteristic of the Purbeck examples. There are usually two or three tubercles in the lumbar group and four in the furcal arc, two fairly large tubercles just behind the alveolus and usually two or three smaller ones on the rostrum.

The stability of the ornament pattern is demonstrated by the percentage frequency of the individual tubercles. In the Mupes and Brede cycles the frequency of occurrence of the tubercles is as follows:

	tubercle	*occurrence per cent*
polar	15	100
ocular group	11a	65
	3c	66
	4d	8
lumbar group	13a	22
	13b	82
	13c	70
ventral arc	5c	61
	6c	62
	7c	79
	9c	78
furcal arc	8b	31
	8c	43
	8d	25
	8e	18
rostral arc	2d	62
	1i	26

In the Bexhill Cycle the relative frequency is: polar (15), ocular group (11a, 3c, 4d), ventral arc (5c, 6c, 7c, 9c), furcal arc (8b, c, d, e) and the two post-alveolar tubercles all 100 per cent; in the lumbar group 59 per cent of individuals have three tubercles, 33 per cent have two and 8 per cent one (a single specimen has been seen without lumbar tubercles); and 84 per cent have two or three tubercles on the rostrum.

During the Bexhill Cycle a new mutant appeared with an ornament pattern not unlike that of *C. wicheri croesi* except for the absence of the ventral arc, and this gradually replaced *C. wicheri* as the dominant species. This new species, *C. morula* (p. 72), has a stable ornament pattern composed of about eight tubercles generally much larger than those in *C. wicheri.*

Distribution. C. wicheri croesi has been found in the following boreholes in the Weald—Warlingham, Mountfield No. 3 and Henfield No. 1.

Cypridea wolburgi sp. nov.

Plate XVI, figs. 3–4

Holotype. GSM Mik(M) 3206001. Dimensions: length 1·0 mm, height 0·705 mm, length/height ratio 1·42. Locality: Warlingham Borehole, Surrey, at 1931 ft 2 in. Horizon: Lulworth Cycle, *Cypridea setina* Zone, Upper Purbeck.

Diagnosis. Carapace triangular-ovate in lateral view. Dorsal margin swollen in both valves; ventral margin strongly swollen (velate) in right valve, less so in left valve. Rostrum small, alveolus very short, cyathus acute-triangular, terminal. Shell surface very finely punctate, almost smooth, except for dorsal and ventral swellings which appear to have a rough pimply surface. The right valve is the larger.

Description. This species is not unlike an inverse form of *C. alta formosa* (p. 52). The nearest comparable inverse species is *C. dunkeri inversa* Martin (p. 62), but this much earlier species is more strongly punctate, has a much larger rostrum, alveolus and cyathus and is without the characteristic dorsal and ventral swellings.

Distribution. *C. wolburgi* first appears in the Greenwood Cycle of the Middle Purbeck, but is commonest in the lowest beds of the Upper Purbeck, i.e. the Lulworth and Mupes Cycles and so serves as a useful stratigraphical indicator. It has been found in the Warlingham Borehole in Surrey; in the Henfield No. 1 Borehole in Sussex; and the Chilcomb Down No. 1 Borehole in Hampshire.

Genus SCABRICULOCYPRIS Anderson, 1941

Scabriculocypris acanthoides Anderson

1941. *Scabriculocypris acanthoides* Anderson, p. 378, pl. xviii, fig. 6.

Holotype. GSM Mik(M) 728001 (formerly GSM 70348). Dimensions: length 0·68 mm, height 0·44 mm, length/height ratio 1·55. Locality: Town Gardens Quarry, Swindon, Wiltshire. Horizon: Middle Pebbly Beds, Lower Purbeck.

Distribution. This is a rare species only certainly known from the Lower Purbeck at Swindon, but an ostracod which may be this species was found in the Mountfield Cycle (Lower Purbeck, *C. dunkeri* Zone) of the Ashdown No. 1 Borehole in Sussex.

Scabriculocypris cerastes Anderson

1941. *Scabriculocypris cerastes* Anderson, p. 378, pl. xviii, fig. 7.

Holotype. GSM Mik(M) 729001 (formerly GSM 70349). Dimensions: length 0·68 mm, height 0·43 mm, length/height ratio 1·58. Locality: Town Gardens Quarry, Swindon, Wiltshire. Horizon: *Chara* Marls, Lower Purbeck.

Distribution. This is a rare species. Apart from the type locality it has only been found in the Warlingham Borehole, Surrey, at the base of the Middle Purbeck (Goldspur Cycle).

Scabriculocypris durlstonensis sp. nov.

Plate XXIII, figs. 6–8

Holotype. GSM Mik(M) 3215001 (Plate XXIII, figs. 7–8). Dimensions: length 1·1 mm, height 0·8 mm, length/height ratio 1·37. Locality: Durlston Bay, Dorset. Horizon: Croydon Cycle, *C. g. fasciculata* Zone, Middle Purbeck.

Figured Specimen. GSM Mik(M) 3216001 (Plate XXIII, fig. 6). Dimensions: length 1·15 mm, height 0·815 mm, length/height ratio 1·43. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1819 ft. Horizon: Nothe Cycle, *C. g. fasciculata* Zone, Middle Purbeck.

Diagnosis. Carapace obovate in lateral view, oval from above with greatest width near the centre of the valves. Anterior margin bordered by a smooth flange. Left valve larger and higher than the right. Surface covered with coarse punctations, almost reticulate in places.

Description. Examples of this species show the characteristic features of *Scabriculocypris*, i.e. the adductor muscle scar pattern and the hingement are like that of *Cypridea*, the ventral margin of the left valve extends well below that of the right valve and the dorsal margin of the right valve projects slightly above that of the left valve.

Apart from these features and the absence of a rostrum and alveolus the carapace resembles some species of *Cypridea*, and in some individuals there is a slight re-entrant in the shell margin where the alveolus is situated in *Cypridea*.

Distribution. S. durlstonensis is only known in England from the Cinder Beds and the strata immediately above, i.e. from the Cinder, Nothe and Croydon cycles (*C. g. fasciculata* Zone). It has been recovered from the Durlston Bay section in Dorset and from the Chilcomb Down No. 1 Borehole in Hampshire but has not yet been seen in the Weald.

Scabriculocypris trapezoides Anderson

Plate XVIII, figs. 6–7

1940. Ostracode (626) Wicher, p. 264, pl. iii, fig. 18.
1940. Ostracode gen. et sp. indet. Martin, p. 358. pl. viii, figs. 121–3.
1941. *Scabriculocypris trapezoides* Anderson, p. 377, pl. xviii, fig. 5.
1960. *Scabriculocypris trapezoides:* Grekoff, pl. x, fig. 89.
1962. *Scabriculocypris trapezoides:* Klingler, Malz and Martin, p. 172, pl. xxvi, fig. 16.
1963. *Scabriculocypris trapezoides:* Oertli, p. 20, pl. vi, figs. 37–9.
1963. *Scabriculocypris? sp.* (127) Christensen: p. 33, pl. v, figs. 2a, b.
1966. *Scabriculocypris trapezoides:* Christensen, p. 466. pl. i, figs. 6, 8.
1966b. *Scabriculocypris trapezoides:* Barker, p. 484, pl. vii, fig. 3.
1966. *Scabriculocypris trapezoides:* Bielcka and Sztejn, fig. 3.
1968. *Scabriculocypris trapezoides:* Christensen, p. 38, figs. 10i–j, lle.

Holotype. GSM Mik(M) 727001 (formerly GSM 70347). Dimensions: length 0·565 mm, height 0·37 mm, width 0·22 mm. Locality: Town Gardens Quarry, Swindon, Wiltshire. Horizon: *Chara* Marls, Lower Purbeck.

Diagnosis. Carapace small, trapezoidal in lateral view, narrow oval from above, oval in end view. Surface covered except near the margins with large shallow punctations arranged in more or less longitudinal rows, almost reticulate. Left valve larger than the right overlapping it anteriorly, posteriorly and especially ventrally.

Description. This small shell is easily recognized by its trapezoidal outline and distinctive shell sculpture. It is without the pustulose ornament which characterizes *S. cerastes* and *S. acanthoides* and is much smaller and more trapezoidal than *S. durlstonensis*.

Distribution. S. trapezoides is characteristic of and often very abundant in the more saline bands of the Lower Purbeck and the lower half of the Middle Purbeck. It is first encountered in the highest beds of the Portland and ranges up to the Nothe Cycle with its maximum development in the Goldspur and Ashdown cycles at the base of the Middle Purbeck.

It has been seen in the Warlingham, Penshurst (1899), and (1938), Ashdown No. 1, Mountfield No. 4, Henfield No. 1, Guestling Nos. 1 and 3, Netherfield Place No. 5 and Brightling No. 27 boreholes and the Goldspur Drift, Mountfield in the Weald; in the Portsdown No. 1, Kingsclere No. 1 and Chilcomb Down No. 1 boreholes in Hampshire; the Durlston Bay section in Dorset; in sections near Aylesbury, Buckinghamshire: and at Swindon in Wiltshire.

Genus RHINOCYPRIS Anderson, 1941

Rhinocypris jurassica (Martin)

Plate XX, fig. 7

1940. *Ilyocypris jurassica* subsp. *jurassica* Martin, p. 313, pl. iv, figs. 51–4; subsp. *spinosa*, p. 316, pl. iv, figs. 55–7.
1941. *Rhinocypris scabra* Anderson, p. 378, pl. xix, fig. 18; and var. *hamata*, p. 379, pl. xix, fig. 19.
1963. *Rhinocypris jurassica jurassica:* Oertli, p. 18, pl. v, figs. 25–7.
1966b. *Rhinocypris jurassica:* Barker, p. 470, pl. vii, figs. 17–8.
1966. *Ilyocypris jurassica jurassica:* Bielcka and Sztejn, fig. 3.
1968. *Rhinocypris jurassica jurassica:* Christensen, p. 26, fig. 7h.

Holotype. SMF X/E 249. Dimensions: length 0·52 mm, height 0·27 mm, width 0·21 mm. Locality: Bohrung Rodewald WA 11, Germany, at 401·5 m. Horizon: Lower Serpulit.

Figured Specimen. GSM Mik(M) 3287001. Dimensions: length 0·45 mm, height 0·25 mm. Locality: Osmington Mills, Dorset. Horizon: Upper Purbeck or basal Wealden.

Description. In this species the spinose ornament is extremely variable, it may be sparse as in *R. jurassica jurassica* (Martin) and *R. scabra scabra* Anderson, or strongly and abundantly spinose as in *R. jurassica spinosa* (Martin). The spines may be slender and straight or heavy and curved as in *R. scabra hamata* Anderson.

There appears to be every possible gradation between these varieties, none of which is so far known to have stratigraphical significance. One variety which appears to be almost without spines has been named as a new species, *R. rasilis*, by Christensen (1968, p. 26, figs. 7i, l).

Distribution. Specimens of *R. jurassica* so far recorded range from the Upper Kimmeridge to the Upper Purbeck in North Germany, throughout the Purbeck in Poland and from Upper Kimmeridge to Lower Purbeck in Scania. In England the species is widely distributed and usually associated with the more saline ostracod assemblages. It is found in the basal Purbeck beds and upwards throughout the Purbeck and the greater part of the Wealden.

Examples have been recovered from the Warlingham Borehole in Surrey; from the Mountfield Nos. 3 and 4, Guestling Nos. 1 and 3, Netherfield Place Nos. 3 and 5, Brightling No. 27, Penshurst (1899) and Henfield No. 1 boreholes and from the sections in Milkhurst Wood, Nine Acre Wood, Binglett's Wood Stream and the Goldspur Drift in Sussex; from the Chilcomb Down No. 1 and Kingsclere No. 1 boreholes in Hampshire; and from Durlston Bay in Dorset.

Genus DAMONELLA Anderson, 1966

Damonella buchaniana Anderson

1966. *Damonella buchaniana* Anderson, p. 441, figs. 17, 21, 24.

Distribution. Ranges from the Upwey Cycle throughout the Purbeck Beds but is nowhere very abundant. It has been seen in all the Weald boreholes examined except Ashdown Nos. 1 and 2.

Damonella ellipsoidea (Wolburg)

1940. *Cypria* sp. ? Martin, p. 356, pl. viii, figs. 119–20.
1949. *Cypria* L61 Wolburg, p. 352, table 3, fig. 5.
1951. ? *Cypria ovalis* Anderson MS, p. 210 (*nomen nudum*).
1962a. *Bythocypris ellipsoidea* Wolburg, p. 223, pl. 32b, fig. 20.
1966. *Damonella ellipsoidea:* Anderson, p. 442, figs. 18, 20, 25–6.

Distribution. Ranges from the Ridgeway Cycle throughout the Purbeck Beds but is most abundant in the Mountfield and Goldspur cycles. Seen in all the Weald boreholes examined except Ashdown Nos. 1 and 2.

Damonella pygmaea (Anderson)

1941. *Cypris pygmaea* Anderson, p. 379, pl. xix, fig. 17.
1951. *Cytherella pygmaea:* Anderson, p. 211.
1963. *Cypris pygmaea:* Oertli, p. 19, pl. v, figs. 34–5.
1966. *Damonella pygmaea:* Anderson, p. 441, figs. 22, 30.

Distribution. Ranges throughout the Purbeck Beds (except for the basal Warren Cycle) but is most abundant in the Mountfield to Durlston cycles. Seen in all the boreholes and sections examined in the Weald.

Family CYPRIDIDAE Baird, 1845

Genus PSEUDOPARACYPRIDOPSIS gen. nov.

Type species. P. mountfieldensis sp. nov.

Diagnosis. Carapace elongate, subquadrate, strong, fairly rotund. Anterior margin evenly rounded with a very narrow indistinct flange, dorsal margin almost straight and oblique to venter, postero-dorsal margin slopes down obliquely to a rounded posterior end. Ventral margin concave and slightly sinuous. Left valve is larger than the right and projects above it in side view and overlaps it slightly along the venter.

Adductor muscle scars a transverse row of four with two behind and with two others anterior and ventral. The pattern is almost exactly that seen in *Paracypridopsis* Kaufmann, 1900. Internal structures not known. The shell surface often appears to be smooth but in well-preserved individuals is seen to be covered with minute, closely-set pustules.

Description. This genus differs from *Paracypridopsis* in that the shell is much larger. It closely resembles *Paracypridopsis* in outline but it is the left valve which projects above the right and not *vice versa.*

Mongolianella Mandelstam, 1956, is similar in shape and size but with a different muscle scar pattern and is without the dorsal overlap. *Pseudoparacypridopsis* is more robust than *Eoparacypris* gen. nov. (p. 106), is less compressed, has a different muscle scar pattern, is less acute posteriorly and has a distinct dorsal overlap of the right valve by the left.

Pseudoparacypridopsis mountfieldensis sp. nov.

Plate XIX, fig. 14

1963. *Eucypris sp.* (146) Christensen, p. 26, pl. v, fig. 5.

Holotype. GSM Mik(M) 3282001, complete carapace. Dimensions: length 1·155 mm, height 0·63 mm. Locality: Chilcomb Down No. 1 Borehole, Hamp-

shire, at 1856 ft. Horizon: Ashdown Cycle, *C. g. granulosa* Zone, Middle Purbeck.

Diagnosis. As for genus.

Description. This common Purbeck species appears to be the same as that figured by Christensen (1963) as *Eucypris sp.* (146) from the Purbeck Beds of Bornholm. It may also be that recorded as Ostracode (581) by Wicher (1940) and that recorded by Martin (1940) as *Eucypris sp.* from the Serpulit and Munde Mergel of N.W. Germany.

Distribution. P. mountfieldensis is found in the *C. dunkeri* and *C. g. granulosa* zones. It ranges from the Lower Soft Cockle Cycle of the Lower Purbeck to the base of the Cinder Beds, being most abundant in the Mountfield and Goldspur cycles. It has been found in the Warlingham Borehole in Surrey; in the Mountfield No. 4, Netherfield Place No. 5, Guestling Nos. 1 and 3, Brightling No. 27 and Henfield No. 1 boreholes and the Goldspur Drift and Milkhurst Wood Sections in Sussex; and in the Chilcomb Down No. 1 Borehole in Hampshire.

Genus MANTELLIANA Anderson, 1966

Mantelliana cyrton sp. nov.

Plate XXIII, figs. 4–5

?1963. '*Cypris*' aff. *purbeckensis* Oertli, pl. v, fig. 33.
1968. *Bairdia* sp. Klingler, 1955: Wienholz, pl. i, figs. 1a–c.

Holotype. GSM Mik(M) 3217001 (Plate XXIII, fig. 4). Dimensions: length 1·35 mm, height 1·07 mm, width 0·8 mm, length/height ratio 1·26. Locality: Mountfield No. 4 Borehole, Sussex, at 406 ft. Horizon: Wardour Cycle, Lower Purbeck.

Topotype. GSM Mik(M) 3218001 (Plate XXIII, fig. 5). Dimensions: length 1·28 mm, height 0·915 mm, length/height ratio 1·4. Locality and horizon as for holotype.

Diagnosis. A large carapace, almost circular in lateral view, fusiform from above, widest in the centre, pear-shaped when seen from the anterior end with the widest part of the shell near the ventral margin. The shell margin has a narrow flange anteriorly, dorsally and posteriorly which is widest dorsally. Adductor muscle scars as for genus. Shell surface covered with very small close set papillae about 0·015 mm diameter. There are a few scattered pustules about 0·035 mm diameter chiefly at the anterior end of the shell. The left valve is the larger.

Description. In *M. cyrton* the shell substance is much thicker than in other members of the genus and the marginal flange is a much more robust structure than the fringe of *M. mantelli* (Jones). The shape and strong dorsal flange of this species distinguish it from all other members of the genus.

The ostracod figured by Oertli (1963 pl. v, fig. 33) as '*Cypris*' aff. *purbeckensis* from the Lower Purbeck of the Villemoyenne 2 Borehole appears to resemble *M. cyrton* very closely except that the median-ventral swelling is somewhat more sharply defined than in the English examples. The *Bairdia sp.* figured by Wienholz (1968, pl. i, figs. 1a–c) also appears to be this species.

Distribution. M. cyrton is found in the upper part of the Lower and the lower part of the Middle Purbeck ranging from the Hard Cockle to the Netherfield cycles (*C. dunkeri* to *C. g. granulosa* zones), but is never very abundant. It has been recovered from the Henfield No. 1, Mountfield No. 4, Guestling No. 3, Netherfield Place Nos. 3 and 5 boreholes and from the Goldspur Drift in Sussex; and from the Chilcomb Down No. 1 Borehole in Hampshire.

Mantelliana purbeckensis (Forbes)

Plate XXIII, fig. 3

1966. *Mantelliana purbeckensis:* Anderson, p. 438 (incl. syn.).
1968. *Mantelliana purbeckensis:* Wienholz, pl. i, figs. 4–5.

Figured Specimen. GSM Mik(M) 3310001 (female). Dimensions: length 1·05 mm, height 0·715 mm, length/height ratio 1·47. Locality: Goldspur Drift, Mountfield, Sussex, at 144 ft 2 in. Horizon: Wardour Cycle, Lower Purbeck.

Distribution. M. purbeckensis is one of the common species of the Lower Purbeck strata, generally associated with *F. boloniensis* in the more saline phases. It has been found wherever the Lower Purbeck has been seen except at Swindon. It has been collected from boreholes and sections in Surrey, Sussex, Hampshire, Dorset and Buckinghamshire (see Barker 1966b, p. 469). It is most common in the middle part of the Lower Purbeck, i.e. the Hard Cockle, Wardour, Lower Soft Cockle and Upper Soft Cockle cycles. It is last seen in the Cinder Beds of the Middle Purbeck.

In the Weald *M. purbeckensis* has been found in the Warlingham, Mountfield Nos. 3 and 4, Netherfield Place Nos. 3 and 5, Brightling No. 27, Henfield No. 1 and Penshurst (1899) boreholes and the Goldspur Drift.

Mantelliana cf. wealdensis (Wolburg)

Plate XXIII, figs. 1–2

1962a. ?*Bythocypris wealdensis* Wolburg, p. 224, pl. xxiib, fig. 21.
1968. ?*Mantelliana* aff. *purbeckensis:* Wienholz, pl. i, fig. 5.

Figured Specimens. GSM Mik(M) 3219001 (female) (Plate XXIII, fig. 1). Dimensions: length 1·17 mm, height 0·82 mm, length/height ratio 1·43. Locality: Netherfield Place No. 5 Borehole, Sussex, at 913 ft 3–4 in. Horizon: Goldspur Cycle, *C. g. granulosa* Zone, Middle Purbeck.

GSM Mik(M) 3220001 (male) (Plate XXIII, fig. 2). Dimensions: length 1·14 mm, height 0·665 mm, length/height ratio 1·72. Locality: Guestling No. 1 Borehole, Sussex, at 1019 ft 2–8 in. Horizon: Goldspur Cycle, *C. g. granulosa* Zone, Middle Purbeck.

Diagnosis. A large thin-walled shell, bean-shaped in side view. Anterior and posterior margins evenly rounded but the posterior is more acute than the anterior. Ventral margin slightly concave, dorsal margin strongly arched, highest near the centre. Anterior and posterior margins bear a narrow flange. The shell surface generally appears to be smooth but occasionally is covered with very fine circular punctations. The left valve is the larger. A dimorphic species.

Description. This large fragile carapace is found in the more saline phases of the Purbeck. Adult forms like the holotype, assumed to be female, are almost symmetrical about the vertical axis and have an average length of 1·13 mm and

an average length/height ratio of 1·5. In juveniles of the prematuration moult with an average length of 0·94 mm and length/height ratio of 1·46 the outline is like that of the adult female except that the posterior end is a little more acute. In the forms presumed to be male dimorphs (Plate XXIII, fig. 2) the average length is 1·2 mm and length/height ratio 1·85, i.e. they are a little longer and much lower shells.

The narrow ridged rim or fringe is characteristic but on account of its fragility is rarely seen intact, especially in the female shell.

The outline of the female form of *M.* cf. *wealdensis* is similar to that of *M. purbeckensis* (Forbes) but the latter is a smaller and thicker shell without the marginal fringe. The form described as *Bythocypris wealdensis* by Wolburg (1962) which has a similar stratigraphical position is very like the female of the ostracod figured here but is much smaller (length 0·8 mm). If it is the same species it can only be an immature form.

Distribution. M. cf. *wealdensis* is abundant at certain horizons, generally found as internal moulds and associated with other forms characteristic of the more saline phases of the Purbeck. It ranges from the Hard Cockle Cycle (Lower Purbeck) upwards and is most abundant in the lower part of the Middle Purbeck.

It has been found in the Warlingham, Henfield No. 1, Guestling Nos. 1 and 3, Netherfield Place Nos. 3 and 5, Penshurst (1899) and Brightling No. 27 boreholes and the Milkhurst Wood and Nine Acre Wood sections in the Weald; and in the Chilcomb Down No. 1 Borehole in Hampshire.

Family PARACYPRIDIDAE Sars, 1923

Genus EOPARACYPRIS gen. nov.

Type species. Eoparacypris weedonensis sp. nov.

Diagnosis. Relatively thin-shelled elongate carapaces with a dolabrate outline. The anterior is evenly rounded and flanged, the dorsal margin curves backwards, sometimes evenly, but more often meeting the anterior margin at an obtuse angle near the anterior end of the hinge. Posterior end acute and usually flanged; ventral margin concave, sinuous. Surface smooth or covered with closely set, very small papillae, or very finely punctate. Left valve the larger but the overlap is small.

Hinge simple, adont, consisting of a groove in the left valve and a bar in the right valve. Adductor muscle scars in a curved row of four scars with two behind and two anterior and ventral to the row. The pattern closely resembles that of the Tertiary genus *Caspiolla* Mandelstam, 1960.

Inner lamellae broad anteriorly and posteriorly. Radial pore canals numerous, canal zone narrow.

Other species. *E. attenuata* sp. nov., *E. abbreviata* sp. nov., *E. edwardi* sp. nov., *E. macroselina* sp. nov., *E. parallela* (Neale), *E. surriensis* sp. nov.

Description. A number of forms found in the Purbeck and Wealden strongly resemble species of the genus *Paracypris* Sars, 1866. However, where the muscle scar pattern has been seen it is quite unlike that of *Paracypris* but closely resembles that of *Caspiolla* and to a less extent that of *Paracypridopsis* Kaufmann,

1900. The shell outline is very like that of *Paracypris* but in *Eoparacypris* the carapace is rarely so elongate or so acute posteriorly and, moreover, is flanged both anteriorly and posteriorly, a feature not recorded as typical of *Paracypris*. It may be that a number of the Mesozoic species previously assigned to the genus *Paracypris* could more properly be regarded as species of *Eoparacypris*.

Sexual dimorphism appears to be present in the genus; generally some individuals in each species are more acute posteriorly than others and may represent male dimorphs.

The size range within the genus is considerable, ranging from *E. edwardi* which is less than 0·5 mm long to *E. macroselina* which may exceed 2 mm in length.

Ecologically the genus may have occupied a similar niche to *Paracypris*, since it is generally to be found in the more saline phases of the Purbeck and Wealden.

Eoparacypris abbreviata sp. nov.

Plate XIX, fig. 7

Holotype. GSM Mik(M) 3278001, complete carapace. Dimensions: length 0·665 mm, height 0·39 mm. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1787 ft. Horizon: Langton Cycle, *C. g. fasciculata* Zone, Middle Purbeck.

Diagnosis. Carapace triangular-ovate in lateral view. Anterior end evenly rounded with a narrow flange. Posterior margin slopes abruptly downwards to meet the ventral margin. Postero-ventral angle carries a short, blunt conical extension. Left valve the larger.

Description. Like most species of *Eoparacypris* this is a delicate shell rarely found undamaged. The holotype and one other specimen from the Chilcomb Down No. 1 Borehole are pyritized and in consequence have been preserved uncrushed.

This species is distinguished from other members of the genus by the manner in which the dorsal margin, which is almost straight, turns sharply into the oblique posterior margin, and by the form of the postero-ventral angle which resembles the cyathus found in this position in the genus *Cypridea*.

Distribution. Though fragmentary specimens which may belong to this species have been found at several horizons in the Purbeck Beds, only those from the Chilcomb Down No. 1 Borehole can be recognized with certainty.

The species has not yet been seen in the Purbeck Beds of the Weald.

Eoparacypris attenuata sp. nov.

Plate XIX, fig. 6

Holotype. GSM Mik(M) 3277001, a complete carapace. Dimensions: length 0·8 mm, height 0·315 mm. Locality: Henfield No. 1 Borehole, Sussex, at 1424–26 ft. Horizon: ?Stair Cycle, Lower Purbeck, but probably derived from a higher level.

Diagnosis. Carapace elongate bean-shaped in lateral view. Anterior and dorsal margins evenly rounded, posterior end acute but rounded. Ventral margin sinuous. Shell surface smooth.

Description. E. attenuata closely resembles *E. weedonensis* (p. 110) but the shell is much more depressed than in that species. It is more elevated than *P. arcuatilis* Donze (1964) and is less acute posteriorly than the *Paracypris sp.* figured by Barker (1966a, pl. 3, figs. 10–3) from the Poxwell Quarry in Dorset. *E. attenuata* resembles the form figured as *Paracypris sp.* by Oertli (1965, pl. 11, fig. 7) from the Tithonian of southern Bavaria but is considerably larger.

Distribution. Though the holotype was found near the base of the Purbeck Beds in the Henfield (percussion) Borehole it was almost certainly derived from a higher horizon. Elsewhere, when collected from core or from an open section, the species occurs only in the Middle Purbeck. It has been found in the Durlston, Cinder Beds and Studland cycles in the Warlingham Borehole, Surrey; the Chilcomb Down No. 1 Borehole, Hampshire; and in the Milkhurst Wood section in Sussex.

Eoparacypris edwardi sp. nov.

Plate XIX, fig. 11

Holotype. GSM Mik(M) 3280001, complete carapace. Dimensions: length 0·42 mm, height 0·265 mm. Locality: Warlingham Borehole, Surrey, at 1788 ft. Horizon: Fairlight Cycle, Wadhurst Clay, Wealden.

Diagnosis. Carapace small, bluntly triangular in lateral view, evenly rounded anteriorly with a small flange, posterior acute but rounded, ventral margin sinuous. Shell surface smooth and glossy.

Description. E. edwardi is much smaller and more elevated than *E. parallela*, relatively shorter than *E. abbreviata* and less acute posteriorly than either.

Distribution. This is a fairly common form in the more saline bands of the upper half of the Wadhurst Clay. What may be the same species occurs in the Henfield Group of strata in the lower part of the Weald Clay.

E. edwardi is especially characteristic of the Fairlight and Lindfield cycles of the Wadhurst Clay in the Wadhurst Park No. 3 Borehole in Sussex and the Warlingham Borehole in Surrey.

Eoparacypris macroselina sp. nov.

Plate XIX, figs. 12–13

Holotype. GSM Mik(M) 3281001, female right valve only (Plate XIX, fig. 12). Dimensions: length 2·02 mm, height 1·04 mm. Locality: Penshurst (1899) Borehole, Sussex, at 629 ft. Horizon: Tisbury Cycle, Upper Purbeck.

Figured Specimen. GSM Mik(M) 3288001, right valve male (Plate XIX, fig. 13). Dimensions: length 1·385 mm, height 0·635 mm. Locality: Netherfield Place No. 3 Borehole, Sussex, at 720 ft 0–1 in. Horizon: Tyneham Cycle, Upper Purbeck.

Diagnosis. A very large thin shell with an elongate-dolabrate outline. Anterior margin evenly rounded and with a narrow flange. Posterior acute. Surface covered closely with extremely minute pustules giving the shell a rough appearance, though in some preservations it may appear to be almost smooth.

Description. Few of these very large thin shells are to be found intact, the holotype is the most complete specimen yet found but many can be reconstructed, and it is clear that the holotype is by no means the largest example

known. Lengths range up to 2·175 mm and heights up to 1·12 mm. The length/height ratio averages about 2·0. No other species of *Eoparacypris* in the Purbeck or Wealden approaches *E. macroselina* in size, the nearest is *E. surriensis* and this is usually less than 1·4 mm in length.

Distribution. The species is not uncommon in some of the more saline phases of the Purbeck Beds, ranging from the Upper Soft Cockle Cycle of the Lower Purbeck to the Battle Cycle of the Upper Purbeck where it is most abundant. It has been recovered from the Warlingham Borehole in Surrey; the Guestling No. 3, Netherfield Place No. 3 and Penshurst (1899) boreholes in Sussex; and the Chilcomb Down No. 1 Borehole in Hampshire.

Eoparacypris parallela (Neale)

Plate XIX, fig. 9

1962. *Paracypris parallela* Neale, p. 433, pl. i, figs. 12a, b.

Figured Specimen. GSM Mik(M) 3283001. Dimensions: length 0·88 mm, height 0·385 mm. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1728 ft. Horizon: Hastings Cycle, basal Wealden.

Description. The holotype of this species is from the Speeton Clay 1 ft 6 in above the base of the Valanginian. Neale's illustration shows a sharper bend between the slope of the dorsal and posterior margins than in the specimen figured here, but amongst the topotypes are some individuals much closer in outline.

The species resembles *Paracypris* more closely in shape than any of the other species attributed to *Eoparacypris* in that the posterior end is very acute. The shell surface in many of the Purbeck–Wealden specimens is seen to be closely pitted by very small shallow punctations but others appear to be completely smooth.

Distribution. E. parallela first appears in the Scallop Cycle of the Middle Purbeck and is abundant in the Tyneham Cycle of the Upper Purbeck and the Hastings Cycle of the Wealden. It has not been found above the base of the Wadhurst Clay.

Specimens have been recovered from the Warlingham Borehole in Surrey; the Netherfield Place No. 3, and Guestling No. 3 boreholes and the Milkhurst Wood section in Sussex; and from the Chilcomb Down No. 1 Borehole in Hampshire.

Eoparacypris surriensis sp. nov.

Plate XIX, fig. 8

Holotype. GSM Mik(M) 3284001, complete carapace. Dimensions: length 1·32 mm, height 0·620 mm, width 0·48 mm. Locality: Warlingham Borehole, Surrey, at 1940 ft 6 in. Horizon: Greenwood Cycle, *C. vidrana* Zone, Middle Purbeck.

Diagnosis. Large elongate carapace, evenly rounded anteriorly, bluntly acute posteriorly. Ventral margin concave. Surface smooth.

Description. In this species the posterior is bluntly rounded without the acute termination of *E. macroselina*, a larger shell, or *E. parallela* which is much smaller. The flanges are far less conspicuous than in *E. macroselina.*

Distribution. Though this elegant shell is not uncommon in the Upper Purbeck beds it is rarely found undamaged. It ranges from the Bacon Cycle to the base of the Wealden and has been found in the Warlingham Borehole in Surrey; in the Guestling No. 1 Borehole in Sussex; and in the Chilcomb Down No. 1 Borehole in Hampshire.

Eoparacypris weedonensis sp. nov.

Plate XIX, fig. 10

1941. *Macrocypris horatiana:* Anderson, p. 380, pl. xix, fig. 16 (*non* Jones and Sherborn 1888, p. 252, pl. v, fig. 2).

Holotype. GSM Mik(M) 3285001, complete carapace. Dimensions: length 0·635 mm, height 0·33 mm, width 0·225 mm. Locality: Netherfield Place No. 5 Borehole, Sussex, at 907 ft 11 in to 908 ft. Horizon: Swanage Cycle, *C. g. granulosa* Zone, Middle Purbeck.

Diagnosis. Medium-sized carapace, bean-shaped in lateral view. Dorsal and anterior margins evenly rounded, posterior acutely rounded, ventral margin concave. Shell surface smooth and glossy.

Description. This species resembles *Macrocypris horatiana* Jones and Sherborn (1888, p. 252, pl. v, fig. 2) from the Fuller's Earth at Midford very closely but is higher anteriorly and the hinge is not like that of *Macrocypris.* In *E. weedonensis* the dorsal margin is more evenly arched than in other species of *Eoparacypris.*

Distribution. E. weedonensis is the commonest ostracod in the more saline phases of the Lower Purbeck and in the Middle Purbeck up to the Studland Cycle. It has been recovered from the Mountfield Nos. 3 and 4, Netherfield Place Nos. 3 and 5, Guestling Nos. 1 and 3, Brightling No. 27, Ashdown No. 1, and Penshurst (1899) boreholes and the Goldspur Drift in Sussex; from the Warlingham Borehole in Surrey; from the Kingsclere No. 1 and Chilcomb Down No. 1 boreholes in Hampshire; and from the Durlston Bay section in Dorset.

Family DARWINULIDAE Brady and Norman, 1889

Genus DARWINULA Brady and Robertson, 1885

Darwinula leguminella (Forbes)

Plate XVIII, fig. 8

1846. *Cypris oblonga* (?): Dunker, p. 60, pl. xiii, fig. 24.
1855. *Cypris leguminella* Forbes, p. 294, fig. 334c.
1865. *Cypris leguminella:* Forbes, p. 378, fig. 368c.
1862. *Cypridea oblonga* (?): Jones, p. 128, pl. v, fig. 31.
1877. *Cypridea leguminella:* Woodward, p. 89.
1885b. *Darwinula leguminella:* Jones, p. 346, pl. viii, figs. 30–1.
1886. *Darwinula leguminella:* Jones, p. 147, pl. iv, figs. 4a–c.
1888. *Darwinula leguminella:* Jones, p. 538.
1940. *Darwinula* (450) *leguminella:* Wicher, p. 268, pl. ii, fig. 8.
1940. *Darwinula leguminella:* Martin, p. 317, pl. iv, figs. 58–61.
1949. *Darwinula leguminella:* Wolburg, p. 352.
1956. *Darwinula leguminella:* Gry, pp. 136, 138.
1959. ? *Darwinula leguminella:* Zalányi, p. 425, figs. 12a–d, 12/a, 13a–c.
non 1961. *Darwinula leguminella:* Martin, p. 119, pl. xiv, fig. 19.

1962. *Darwinula leguminella:* Klingler, Malz and Martin, p. 187, pl. xxv, fig. 14.
1963. *Darwinula leguminella:* Oertli, p. 20, pl. vi, fig. 40.
1966b. *Darwinula leguminella:* Barker, pl. vii, fig. 9.

Figured Specimen. GSM Mik(M) 3323001. Dimensions: length 0·62 mm, height 0·26 mm. Locality: Mountfield No. 3 Borehole, Sussex, at 205 ft 6 in. Horizon: Brede Cycle, Upper Purbeck.

Distribution. Ranges throughout the Purbeck and Wealden beds. In the Weald it has been found from the Upwey Cycle upwards in all the boreholes and sections examined.

Darwinula oblonga (Roemer)

Plate XVIII, fig. 9

1839. *Cypris oblonga* Roemer, p. 52, pl. xx, fig. 21.
1846. *Cypris oblonga:* Dunker, p. 60, pl. xv, fig. 26.
1862. *Cypridea oblonga:* Jones, p. 128, pl. v, figs. 31–4.
1885b. *Cyprione bristovii* Jones, p. 344, pl. viii, figs. 27–9, 32.
1940. *Cyprione oblonga:* Martin, p. 319, pl. iv, figs. 62–3; pl. xi, fig. 164; pl. xii, fig. 173.
1940. *Cyprione* (628) *bristovii:* Wicher, p. 268, pl. ii, fig. 7.
1949. *Cyprione oblonga:* Wolburg, p. 352.
1951. *Cyprione oblonga:* Steghaus, p. 209, pl. xiv, fig. 8.
1955. *Cyprione oblonga:* Schmidt, p. 53.
1956. *Cyprione oblonga:* Gry, pp. 136, 138.
1960. *Darwinulina* sp. Donze, p. 14, pl. ii, figs. 17–8.
non 1960. *Cyprione* cf. *C. oblonga:* Neale, p. 214, pl. i, figs. 6–8; pl. iii, figs. 9a, b, 11a, b; pl. iv, figs 1–4.
1962. *Darwinula oblonga:* Klingler, Malz and Martin, p. 188, pl. xxvii, fig. 18.
1962. *Darwinula* cf. *oblonga:* Krummelbein, p. 492, pl. lviii, fig. 37.
1963. *Darwinula oblonga:* Oertli, p. 20.
1963. *Darwinula oblonga:* Christensen, p. 23, pl. ii, figs. 5a–c.

Figured Specimen. GSM Mik(M) 3324001. Dimensions: length 1·15 mm, height 0·525 mm. Locality: Warninglid Borehole, Sussex, at 48–9 ft. Horizon: *C. dorsispinata* Zone, Weald Clay.

Distribution. Ranges throughout the Purbeck and Wealden Beds. In the Weald it was first seen in the Hard Cockle Cycle and accompanied *D. leguminella* in most of the samples examined.

Darwinula jonesi sp. nov.

Plate XVIII, fig. 10

Holotype. GSM Mik(M) 3326001. Dimensions: length 0·935 mm, height 0·385 mm, width 0·35 mm approx. Locality: Wateringbury, near Maidstone, Kent. Horizon: *Cypridea tenuis* Zone, Weald Clay.

Diagnosis. Outline of carapace a rounded oblong. Dorsal margin convex, ventral margin concave. Lowest and narrowest at anterior end, highest near centre of valve. Surface smooth. Valves subequal.

Description. A carapace smaller, more depressed and much flatter than that of *D. oblonga* (Roemer), much larger than *D. leguminella* (Forbes) but with similar length/height and length/width ratios. Unlike both these species the centre of the valve is the highest part, whereas in *D. oblonga* and *D. leguminella*

the highest part of the valve is well behind the centre. The dorsum is gently and evenly concave whilst the venter is very slightly concave. The anterior and posterior ends are evenly rounded but the anterior is a little narrower than the posterior. The muscle scars are those of the genus. The hinge has not been seen. Length/height ratio 2·4, length/width ratio 2·7.

Distribution. D. jonesi has been found most abundantly in the lower half of the *C. tenuis* Zone of the Weald Clay at Atherfield in the Isle of Wight; in the Warlingham Borehole, Surrey; and at Wateringbury near Maidstone in Kent. It first appears in the Scallop Cycle of the Middle Purbeck but is rare in the Purbeck Beds. In the Weald it has only been seen in the Mountfield No. 3 and Brightling No. 27 boreholes.

Family CYTHERIDAE Baird, 1850

Genus FABANELLA Martin, 1961

Fabanella ansata (Jones)

Plate XX, fig. 3

1885b. *Candona ansata* Jones, p. 349, pl. ix, figs. 9–12.
1894. *Cythere wilsoni* Jones, p. 167, pl. ix, figs. 11a–c.
1947. *Candona ansata:* Anderson *in* Arkell, p. 129, text-fig. 28/9.
1963. *Fabanella ansata:* Oertli, p. 22, pl. vi, figs. 43–5.
1964. *Fabanella ansata:* Anderson, p. 155, pl. xi, figs. 37–40; pl. xii, figs. 60–1.
1966b. *Fabanella ansata:* Barker, p. 472, pl. vii, fig. 8.
1966. *Fabanella ansata:* Christensen, p. 465, pl. i, fig. 3.

Lectotype (here selected). BM I. 1654 figd. Jones 1885b, pl. ix, fig. 10. (T. R. Jones Coll. 363/3). Dimensions: length 0·86 mm, height 0·54 mm, width 0·41 mm, length/height ratio 1·59. Locality: South Oving, Buckinghamshire. Horizon: Lower Purbeck.

Diagnosis. Carapace sub-oblong in lateral view, obliquely rounded anteriorly and posteriorly. Dorsal margin straight, ventral margin slightly concave. Valves highest near the posterior end. Surface smooth and glossy. Adductor muscle scars like *Cytheridea.* Hinge simple, adont. Left valve the larger.

Description. This species was adequately described and figured by Jones (1885b) but was assigned to the genus *Candona* perhaps because of its general resemblance to the Recent species *Candona candida* (Müller). The muscle-scar pattern is, however, quite unlike that of *Candona.* As no holotype was indicated by Jones, the specimen figured by him in pl. ix, fig. 10 is here selected as lectotype.

Distribution. C. ansata is fairly common in the Lower Purbeck certainly ranging upwards as far as the Upper Soft Cockle Cycle and possibly as high as the Burwash Cycle of the Lower Purbeck. It is frequently associated with *F. boloniensis* and *Mantelliana purbeckensis* (Forbes) and all three appear to have favoured a hypersaline environment as they are generally the only species found in the gypsum-bearing strata.

In the Weald *F. ansata* has been collected from the Warlingham, Mountfield No. 4, Brightling No. 27, Penshurst (1899) and Henfield No. 1 boreholes and from the Goldspur Drift.

Fabanella boloniensis (Jones)

Plate XX, fig. 1

1882. *Cythere boloniensis* Jones, pp. 615–6, figs. A, B.
1885a. *Cythere Boloniensis:* Jones, p. 58, figs. 1–9.
1885b. *Candona bononiensis* Jones, p. 348, pl. ix, figs. 7–8.
1894. *Cythere sp.* Jones, p. 167, pl. ix, fig. 12.
1940. *Candona* (449) Wicher, p. 264, pl. iii, fig. 16.
1940. *Cyprideis polita* Martin, p. 352, pl. vii, figs. 110–13; pl. ix, figs. 149–51.
1951. '*Candona*' *bononiensis:* Anderson, pp. 210–11.
1953. *Cyprideis polita ornata* Steghaus, p. 42, pl. 2.
1955. *Cyprideis polita ornata:* Klingler, p. 236, pl. xix A.
1955. *Cyprideis polita:* Bartenstein and Burri, pl. xxix.
1955. *Cyprideis ansata:* Bartenstein and Burri, pl. xxix
1956. *Cyprideis polita:* Gry, p. 138.
1960. *Cyprideis* aff. *polita ornata:* Donze, p. 15, pl. ii, figs. 19–22.
1961. *Fabanella polita:* Martin, pp. 185–6, pl. i, figs. 1–4, 10–2.
1961. *Fabanella polita polita:* Martin, p. 113, pl. xiv, fig. 9.
1961. *Fabanella polita polita* and *inflata:* Wolburg, pp. 197, 199, pl. i, figs. 1–3.
1962a. *Neocytheridea bononiensis bononiensis* and *inflata:* Wolburg, pp. 218–9, pl. xxxii b, figs. 1–3.
1963. *Fabanella polita polita* and *ornata:* Oertli, p. 21, pl. vi, figs. 41–2; pl. vii, figs. 46–52.
1963. *Neocytheridea bononiensis bononiensis:* Christensen, p. 36.
1964. *Fabanella boloniensis:* Anderson, p. 155, pl. xi, fig. 45; pl. xii, figs. 62–3.
1966b. *Fabanella boloniensis:* Barker, p. 472, pl. vii, fig. 7.
1966. *Fabanella boloniensis:* Christensen, p. 465, pl. i, fig. 5.

Neotype. Specimen figured by Oertli 1963, pl. vii, fig. 51 as *Fabanella polita polita*, here designated. Internal mould, male. Lower part of Lower Purbeck, Boulogne-sur-Mer.

Figured Specimen. BM I. 1674 (T. R. Jones Coll. 351/1). Dimensions: length 1·45 mm, height 0·8 mm, width 0·76 mm. Locality: Hartwell, Buckinghamshire. Horizon: ?Lower Purbeck.

Diagnosis. Carapace sub-oblong in lateral view, evenly rounded anteriorly and posteriorly, highest behind the middle, a distinct antero-dorsal angle. Venter sinuous. Surface smooth, faintly reticulate or punctate according to preservation. Adductor muscle scars of *Cytheridea* type, a vertical row of four with two anterior. Hinge simple, two flange-like teeth in right valve articulating with long narrow sockets in the left valve. Left valve the larger, overlap small except along venter.

Description. As will be seen from the long synonymy above this ostracod has been variously named. Not only did the original designation of the species lead to confusion but the genus to which it should be assigned has been subject to continual review.

In 1882, Jones figured ostracods obtained from the Purbeck Beds at Boulogne which he named *Cythere boloniensis* varieties A and B. Since the original material cannot now be found much depends on Jones's description and figures, both of which are inadequate. Martin (1961) working with topotype material regarded these varieties as separate species, one of which, var.B, was the same as his own species *Cyprideis polita* and the other, var.A, was *Cythere boloniensis* Jones, 1882 but not the *Candona bononiensis* Jones, 1885b.

Oertli (1963) claims that this var.A, is the *Cypris purbeckensis* of Forbes, 1855. He points out that Jones (1885a, p. 58) noted a resemblance between the subreniform variety A and *C. purbeckensis*. This is true but it is important to remember also Jones's conclusions. After examining the type material from which *C. purbeckensis* was described by Forbes and comparing it with his Boulogne specimens Jones wrote (1885a, p. 58) "After a continued and careful search, however, we cannot find on the slab from Purbeck any valve that has the broadly oblong outline of what I regard as *C. Boloniensis* (see figs. 1–9)". Thus by direct comparison Jones was satisfied that his species *C. boloniensis* varieties A and B were not conspecific with *C. purbeckensis*. When Jones refigured the two species (1885b, pl. ix, figs. 1–6 and 7, 8) it was made quite clear that he not only believed them to be separate species but also to belong to separate genera.

The present writer is in complete agreement with this conclusion and further does not believe that Jones could have confused these two species, even when dealing with juveniles. Jones referred to *C. boloniensis* as "broadly oblong in outline" and it will be noted that even when figuring his 'subreniform variety' he showed the anterior end of the shell as lower than the posterior whereas he was aware and in 1885b (pl. ix, fig. 6), illustrated that in *C. purbeckensis* the anterior end is higher than the posterior.

This confusion between the species *C. purbeckensis* and *C. boloniensis* is not to be ascribed to T. R. Jones but to subsequent workers who have misinterpreted what, it must be admitted, are his very poor illustrations and inadequate descriptions of 1882 and 1885a, whilst not accepting the clear distinctions shown by his illustrations and fuller descriptions of 1885b.

The present writer here designates as neotype of *C. boloniensis* the first specimen from the type locality to be figured since 1882, i.e. that illustrated by Oertli in 1963, pl. vii, fig. 51, which clearly indicates the form to which Jones intended the name to apply.

The variations in surface texture, i.e. from smooth to punctate, are believed to be due to differences in preservation. The Lower Purbeck forms generally have a thin coating of carbonate and moreover frequently occur with ooliths and pisoliths. Where found in shales and mudstones the shell surface is more often punctate.

The subspecies *inflata* of Wolburg may be a sexual dimorph as has been suggested by Christensen (1963, p. 38). Measurements by the present writer suggest that *C. boloniensis* is dimorphous. The length/height ratio increases regularly from about 1·63 in the earliest instars seen to about 1·96 in the latest, i.e. the carapace increases in relative as well as absolute length. The width of the carapace is variable. The length/width ratio is reasonably constant up to about a length of 0·8 mm after which there is a wide divergence. At a length of 0·7 mm the length/width ratio is 2·15; at a length of 1·0 mm there are narrow forms with a length/width ratio of 2·7 and wide forms with the ratio 1·83. This increase in width is chiefly in the posterior half of the carapace suggesting that the wide forms are female dimorphs.

Distribution. F. boloniensis is found in the highest beds of the Portland and becomes very abundant in the Lower Purbeck. It occurs throughout the Middle Purbeck in the more saline phases up to the Cinder Beds after which it is rarely seen but does occur sporadically even in the Wealden. The species has been found everywhere where the Purbeck Beds are exposed.

Fabanella dimorpha sp. nov.

Plate XX, fig. 2

Holotype. GSM Mik(M) 3214001. Dimensions: length 1·09 mm, height 0·62 mm, length/height ratio 1·76. Locality: Kingsclere No. 1 Borehole, Hampshire, at 1382 ft. Horizon: Lulworth Cycle, *C. setina* Zone, Upper Purbeck.

Diagnosis. Carapace rounded trapezoidal in lateral view, ovate from above, almost circular from behind. Anterior margin with a strong flange, ventro-lateral area swollen and overhanging the ventral margin, postero-dorsal and ventral slopes oblique making the posterior rather acute. Surface finely punctate, the punctations being arranged in longitudinal rows in the ventral area. Left valve the larger.

Description. This species is not unlike *F. boloniensis* but in lateral view the venter is more sinuous and the posterior end more acute. The anterior flange is stronger than in *F. boloniensis* particularly in the ventral part.

In shape *F. dimorpha* resembles *Cyprideis? oleroni* Donze (1960, p. 16, pl. iii, figs. 25–30) but lacks the characteristic normal pore canals of that species. It is lower posteriorly than *F. ansata.* Juveniles differ from the adult in being lower and narrower posteriorly.

There appears to be sexual dimorphism in *F. dimorpha* as in *F. boloniensis*, some forms thought to be females are shorter and fatter than those believed to to be males.

Distribution. This is a scarce form known only as yet from the lowest part of the Upper Purbeck (Lulworth Cycle) in the Kingsclere No. 1 Borehole, Hampshire.

Family BRACHYCYTHERIDAE Puri, 1954

Genus MACRODENTINA Martin, 1940

Discussion. The genus *Macrodentina* includes some of the most abundant species of the uppermost Portland Beds. It is characterized by a dentition in which the anterior element of the hinge consists in the right valve of a peg-like tooth, behind which is a socket continued as a groove to the posterior element, which consists of a flange-like tooth divided into five or six denticles.

In the left valve the anterior hinge element is a socket to accommodate the tooth of the right valve, followed by a peg-like tooth which articulates with the socket of the right valve and continues backwards in the form of a bar as far as a posterior socket subdivided to accommodate the denticles of the right valve. This is the hinge structure as described by Martin and is that found in the adults of *M. retirugata* (Jones). But the hinge structure in this species changes during ontogeny.

An adult right valve 1·12 mm long showed the peg-like anterior tooth but the posterior tooth consisted of only three denticles of which the centre one was the largest. Another individual 0·85 mm long showed six denticles in the posterior element, three of which were very small. Two individuals, 0·7 and 0·59 mm long respectively, had six denticles in the posterior element and the anterior element was also a flange-like tooth with six denticles.

In *M. rugulata* (Jones) three adults of lengths 0·97, 0·835 and 0·775 mm respectively had a dentition in the left valve like that of *M. retirugata*. In another individual 0·77 mm long the anterior element of the right valve consisted of five denticles of which the posterior one was large and the remaining four graded downwards to the anterior exactly as illustrated by Sylvester-Bradley (1956, pl. iv, fig. 10). This last is the type of anterior hinge element seen in an adult *M. transiens* (Jones) length 0·58 mm, whilst juveniles again had six to seven denticles in the anterior element as in *M. rugulata*.

Thus the three species *M. retirugata*, *M. rugulata* and *M. transiens* all have in the early stages a common type of hinge structure which in the adult approaches that described as typical of the genus in that one of the posterior denticles in the anterior element becomes larger than the rest and takes over the function of articulation with the opposite valve. This appears to be an intergraded series and the subgenera proposed by Malz (1958)—raised to generic level by Benson and others 1961—seem to be of dubious value.

The genus is also characterized by a marked sexual dimorphism in that some individuals presumed to be males are relatively longer and lower than others which may be females.

Macrodentina mediostricta (Sylvester-Bradley)

Plate XXI, fig. 4

1941. *Cythere retirugata* var. *textilis:* Anderson, p. 374, pl. xviii, fig. 2 (*non* Jones 1885b, p. 350, pl. ix, fig. 24).
1956. *Dictyocythere* (*Dictyocythere*) *mediostricta* Sylvester-Bradley, p. 16, pl. iii, figs. 2–6.
1962a. *Macrodentina mediostricta transfuga* Wolburg, p. 223, pl. xxxii b, fig. 19.

Figured Specimen. GSM Mik(M) 3292001. Left valve, male. Dimensions: length 1·09 mm, height 0·59 mm. Locality: Milkhurst Wood, Sussex. Horizon: Middle Purbeck.

Remarks. The specimen figured by Anderson in 1941 as *Cythere retirugata textilis* from the Poxwell Road Cutting in Dorset is almost certainly a female example of *Macrodentina mediostricta*, although in this shell the characteristic constriction in the mid-dorsal region is not very evident. In the female carapace, however, this is often the case. In general the shell is larger than in *M. retirugata* and is more coarsely reticulate (compare Sylvester-Bradley 1956, pl. iii, figs. 2–6 with figs. 7–10 on the same plate and with Plate XXI, fig. 3).

Distribution. In England this species is characteristic of the more saline phases of the upper part of the Middle Purbeck (Corfe to Greenwood cycles). It has been found in the Warlingham Borehole in Surrey; the Henfield, Mountfield No. 3, Guestling No. 1, Ashdown No. 1, and Brightling No. 27 boreholes, and the Milkhurst Wood section in Sussex; in the Chilcomb Down No. 1 and Kingsclere No. 1 boreholes in Hampshire; and in the Durlston Bay and Poxwell Road Cutting sections in Dorset.

Macrodentina retirugata (Jones)

Plate XXI, fig. 3

1885b. *Cythere retirugata* Jones, p. 350, pl. ix, figs. 21–3; var. *textilis*, p. 350, pl. 9, fig. 24.
1894. *Cythere retecostata?* Jones, p. 166, pl. ix, fig. 10.

1941. *Cythere retirugata* var. *textilis*, Anderson, p. 374, pl. xviii, fig. 3; var. *decorata* nov., p. 374, pl. xviii, fig. 4.
1940. *Macrodentina retirugata*, Martin, p. 330, pl. v, figs. 74–8.
1956. *Dictyocythere* (*D.*) *retirugata:* Sylvester-Bradley, p. 15, pl. iii, figs. 7–10; pl. iv, figs. 3–4, 11, 16–7; and *Dictyocythere* (*D.*) *decorata*, p. 17, pl. iii, fig. 1.
1958. *Macrodentina* (*D.*) *retirugata:* Malz, p. 25, pl. vi, figs. 87–8; and *Macrodentina* (*D.*) *textilis*, p. 26, pl. vi, figs. 89–91.
1964. *Macrodentina retirugata:* Anderson, p. 154, pl. x, fig. 12.
1966a. *Macrodentina* (*D.*) *retirugata:* Barker, p. 453, pl. i, figs. 1–8.
1966b. *Macrodentina* (*D.*) *retirugata:* Barker, p. 476, pl. viii, figs. 18–22.
1968. *Macrodentina retirugata:* Christensen, p. 35, fig. 12.

Figured Specimen. GSM Mik(M) 720001 (formerly GSM 70340). Dimensions: length 0·88 mm, height 0·5 mm. Locality: Town Gardens Quarry, Swindon, Wiltshire. Horizon: Middle Pebbly Beds, uppermost Portland or basal Purbeck.

Distribution. The lectotype (Sylvester-Bradley 1956) came from the highest Portland Beds of Hartwell, Buckinghamshire, and Jones also recorded the species from Swindon (1885b, p. 350). Many examples were collected by Sylvester-Bradley from Swindon some of which were illustrated by Anderson (1941) but which included one specimen from the Middle Purbeck of the Poxwell Road Cutting (pl. xviii, fig. 2) which would now be identified as a specimen of *Macrodentina mediostricta* (Sylvester-Bradley).

Martin's material came from the Lower Serpulit of the Rodewald Borehole. Barker (1966a, p. 453) obtained specimens from the Portland Beds of Poxwell Quarry, Hounstout Cliff, West Weare Cliff and Friar Waddon in Dorset and from the highest Portland and possibly basal Purbeck of the Aylesbury district. Christensen (1968) reported the species from the Lower Purbeck of Scania.

In England *M. retirugata* is certainly present in the uppermost Portland Beds and probably extends for a short distance into the Lower Purbeck. But it has not yet been found in the Purbeck Beds of the Weald and in Dorset its occurrence is limited to brackish-water phases which may be equally well classified in the Portland as in the Purbeck Beds.

Macrodentina rugulata (Jones)

Plate XXI, fig. 2

1885b. *Cythere retirugata* var. *rugulata* Jones, p. 350, pl. ix, figs. 17–20.
1941. *Cythere retirugata* var. *rugulata:* Anderson, p. 373, pl. xviii, fig. 1.
1956. *Dictyocythere* (*Rhysocythere*) *rugulata:* Sylvester-Bradley, p. 18, pl. iv, figs. 1–2, 5–10, 12–5.
1958. *Macrodentina* (*M.*) *rugulata:* Malz, p. 18, pl. vi, figs. 83–6.
1966a. *Macrodentina* (*M.*) *rugulata:* Barker, p. 452, pl. 2, figs. 9–12.
1966b. *Macrodentina* (*M.*) *rugulata:* Barker, p. 475, pl. viii, figs. 16–7.

Figured Specimen. GSM Mik(M) 3290001. Dimensions: length 0·77 mm, height 0·460 mm. Locality: Warren House Farm, Stewkley, Buckinghamshire. Horizon: basal Purbeck or uppermost Portland.

Distribution. Like *M. retirugata* and *M. transiens* this species is found in the highest Portland Beds, e.g. in Poxwell Quarry, Hounstout Cliff, Friar Waddon and West Weare Cliff in Dorset (Barker 1966, p. 453); in the basal Purbeck or uppermost Portland beds in Bugle Pit, at North Whitchurch, Warren House Farm, Haddenham, Towesey and Coneyhill in Buckinghamshire (Barker 1966b,

p. 475); and in the basal Purbeck or uppermost Portland Beds at Swindon in Wiltshire (Anderson 1941, p. 373). It has not yet been recorded from any of the boreholes or sections in the Weald.

Macrodentina transiens (Jones)

Plate XXI, fig. 1

1885. *Cythere transiens* Jones, p. 349, pl. ix, figs. 13–6.
1956. *Dictyocythere* (*Rhysocythere*) *transiens:* Sylvester-Bradley, p. 19, pl. iii, figs. 11–3.
1958. *Macrodentina* (*M.*) *transiens:* Malz, p. 17, pl. vi, figs. 81–2.
1966a. *Macrodentina* (*M.*) *transiens:* Barker, p. 452, pl. ii, figs. 13–5.
1966b. *Macrodentina* (*M.*) *transiens:* Barker, p. 476, pl. viii, figs. 1–6.

Figured Specimen. GSM Mik(M) 3291001. Dimensions: length 0·63 mm, height 0·365 mm. Locality: Warren House Farm, Stewkley, Buckinghamshire. Horizon: basal Purbeck or uppermost Portland.

Distribution. As in the case of *M. retirugata* and *M. rugulata*, *M. transiens* has been found in the uppermost Portland Beds and in strata which may represent a transition from Portland to Purbeck conditions. It has been found in Portland Beds at West Weare Cliff and in Poxwell Quarry in Dorset (Barker, 1966a, p. 452); in what may be transition beds at Bugle Pit, North Whitchurch, Stewkley and Coneyhill in Buckinghamshire, and at Swindon in Wiltshire (Sylvester-Bradley, 1956, p. 19; Barker 1966b, p. 476); but has not yet been recorded from the Purbeck Beds in the Weald.

Family CYTHERURIDAE G. W. Müller, 1894

Genus ORTHONOTACYTHERE Alexander, 1933

The earliest recorded species of *Orthonotacythere* in the Purbeck Beds is *O. rimosa* Martin (1940) first described from the Lower Serpulit of north Germany. Barker (1966a, 1966b) recorded this species from the Portland Beds of Dorset and the Lower Purbeck Beds of Buckinghamshire, and Christensen (1968) from the Upper Jurassic (Lower Purbeck) of Scania.

In the Lower Soft Cockle Cycle (Lower Purbeck) of the Netherfield Place No. 5 Borehole in Sussex a different form occurs in which the median rib is nearer the centre of the shell and the median and ventral nodes are stronger than in *O. rimosa*. This is *O. favulata* Martin (1940), which was first described from Germany at about the horizon of the Mountfield Cycle and from slightly higher (?Netherfield Cycle), i.e. from the uppermost Lower Purbeck and the lower part of the Middle Purbeck. In England *O. favulata* has been found in the S-phases of the Lower Soft Cockle, Ringstead, Robertsbridge, Ashdown, Swanage, Netherfield and Durlston cycles, that is with much the same stratigraphical range as in Germany.

In the Durlston Cycle some individuals exhibit a more complex ornament pattern approaching that of *O. cineraria* sp. nov. which is the dominant form in the Cinder Beds, where it is accompanied by the rather exotic species *Stillina arkelli* sp. nov. (p. 121). *O. cineraria* is also found in the Nothe Cycle and more rarely up to the Scallop Cycle.

In the Cinder Beds a few individuals are found which resemble *O. favulata* in rib pattern but with the ocular and median nodes enlarged, though less so than in *O. inversa* (Cornuel). This form, *O. nodosaria* sp. nov., becomes the

characteristic species of the upper part of the Middle Purbeck (Cinder Beds to Greenwood Cycle) and has been found as high as the Mupes Cycle of the Upper Purbeck.

In all the species named sexual dimorphism is well marked. The males are relatively shorter and have an acute posterior end so that the outline of the shell is more triangular than in the female, in which the posterior half of the shell is extended and higher so that the outline becomes a rounded oblong.

Orthonotacythere cineraria sp. nov.

Plate XXII, fig. 4

Holotype. GSM Mik(M) 3268001, male carapace. Dimensions: length 0·575 mm, height 0·31 mm. Locality: Poxwell Road Cutting, Dorset. Horizon: Cinder Beds, Middle Purbeck.

Diagnosis. Carapace triangular in lateral view, rounded anteriorly. Anterior and posterior ends with a wide flange. Latero-ventral vela overlap the ventral margin. Surface divided by numerous ribs which form a coarse reticulate pattern. Areas between the ribs with wide shallow punctations. Ocular node large, median and postero-ventral nodes small but clearly defined.

Description. O. cineraria is not unlike *Stillina arkelli* sp. nov. (p. 121), but the vela are much smaller and the ribbing extends over the whole shell surface. It is a larger species than *O. rimosa* and relatively longer and the rib pattern is more complex. *O. favulata* is smaller and has a simpler rib pattern than *O. cineraria* and the inter-rib areas are strongly reticulate. *O. nodosaria* has a rib pattern much more like that of *O. rimosa* but with stronger nodes.

Distribution. O. cineraria is sometimes very abundant in the Cinder Beds of the Middle Purbeck and has also been found in the Peveril Cycle below and the Nothe Cycle above. It has been recovered at this horizon from the Warlingham Borehole in Surrey; the Ashdown No. 1 and Mountfield No. 3 boreholes and in the Goldspur Drift, Milkhurst Wood and Nine Acre Wood sections in Sussex; and from the Poxwell Road Cutting in Dorset.

Orthonotacythere favulata Martin

Plate XXII, figs. 2–3

1940. *Orthonotacythere favulata* Martin, p. 332, pl. v, figs. 79–80; pl. vi, figs. 81–3; pl. xi, figs. 162–3.

Holotype. SMF X/E 768. Dimensions: length 0·53 mm, height 0·32 mm. Locality: Bohrung Thören WA 1, Germany, at 781 m. Horizon: Serpulit.

Figured Specimens. GSM Mik(M) 3264001, female right valve (Plate XXII, fig. 3). Dimensions: length 0·590 mm, height 0·31 mm. Locality: Netherfield Place No. 5 Borehole, Sussex, at 895 ft 0–1 in. Horizon: Durlston Cycle, *C. g. fasciculata* Zone, Middle Purbeck.

GSM Mik(M) 3273001, male carapace (Plate XXII, fig. 2). Dimensions: length 0·54 mm, height 0·31 mm. Locality as before at 895 ft 4–5 in. Horizon: Durlston Cycle, *C. g. fasciculata* Zone, Middle Purbeck.

Description. This species is not always easy to distinguish from *O. rimosa* as the strength of the ornament varies considerably and the basic pattern is similar. Martin figured two forms, one trapezoidal in outline (pl. v, figs. 79–80)

probably the female, and a more triangular shell (pl. vi, fig. 81) probably a male. In English material the ribs appear to be more strongly developed than in German specimens, which brings them closer to *O. rimosa* in appearance, and often it is only the position of the median rib and the presence of more clearly defined nodes which distinguishes them.

Distribution. In England *O. favulata* ranges from the Lower Soft Cockle Cycle of the Lower Purbeck to the Durlston Cycle of the Middle Purbeck. It has been found in the Mountfield No. 4, Guestling Nos. 1 and 3 and Netherfield Place No. 5 boreholes and the Goldspur Drift in Sussex; in the Warlingham Borehole, Surrey; and in Durlston Bay, Dorset.

Orthonotacythere nodosaria sp. nov.

Plate XXII, figs. 5, 6

Holotype. GSM Mik(M) 3265001, complete male carapace (Plate XXII, fig. 6). Dimensions: length 0·59 mm, height 0·36 mm. Locality: Mountfield No. 3 Borehole, Sussex, at 297 ft. Horizon: Langton Cycle, *C. g. fasciculata* Zone, Middle Purbeck.

Figured Specimen. GSM Mik(M) 3266001, female carapace (Plate XXII, fig. 5). Dimensions: length 0·54 mm, height 0·325 mm. Locality: Poxwell Road Cutting, Dorset. Horizon: Cinder Beds, *C. g. fasciculata* Zone, Middle Purbeck.

Diagnosis. Male carapace triangular, female carapace oblong in lateral view. Surface ornamented with ribs between which are reticulate areas. Ocular node well developed, median node fairly strong. Ventral and posterior nodes small but distinct. Conspicuous sexual dimorphism.

Description. This species bears a strong resemblance to *O. favulata* (p. 119) both in shape and ornament but is distinguished from that species by the greater development of the dorsal nodes. *O. cineraria* (p. 119) has a more complex rib pattern. In *O. favulata* the ribs are much less developed especially in the posterior half of the shell, a feature even more marked in the female. *O. auricula* Martin, *O. inversa* (Cornuel) and *O. elongata* Barker have more lobate ribs and in *O. levis* Barker the surface is unornamented.

Distribution. A form resembling *O. nodosaria* appears in the Cinder Beds of the Middle Purbeck but the species can be first definitely recognized in the Royal Cycle, above which it occurs in the Langton, Corfe, Scallop and Studland cycles, i.e. the upper part of the Middle Purbeck. In the Poxwell Cycle the ribs tend to be more lobate so that the ornament pattern approaches that of *O. auricula* Martin. It has not been seen above the Mupes Cycle of the Upper Purbeck.

The species has been found in the Warlingham, Mountfield No. 3, Brightling No. 27 and Guestling No. 1 boreholes in the Weald.

Orthonotacythere rimosa Martin

Plate XXII, fig. 1

1940. *Orthonotacythere rimosa* Martin, p. 335, pl. vi, figs. 84–6.
1941. *Orthonotacythere rimosa:* Triebel, pl. xv, fig. 174.
1961. *Orthonotacythere* cf. *rimosa:* Martin, p. 117, pl. xiv, figs. 21a–c.
1966a. *Orthonotacythere rimosa:* Barker, p. 454, pl. v, figs. 7–8, 11–2.
1966b. *Orthonotacythere rimosa:* Barker, p. 478, pl. viii, figs. 12–3.
1968. *Orthonotacythere rimosa:* Christensen, p. 41, figs. 8a, 9i, 11h–j.

Holotype. SMF X/E 344. Dimensions: length 0·53 mm, height 0·33 mm. Locality: Bohrung Thören WA 1, Germany, at 786 m. Horizon: Lower Serpulit.

Figured Specimen. GSM Mik(M) 3272001, male, left valve only. Dimensions: length 0·565 mm, height 0·33 mm. Locality: Quainton, Buckinghamshire. Horizon: Lower Purbeck.

Description. The ornament pattern in *O. rimosa* differs from that of both *O. favulata* and *O. nodosaria* in that the anterior area is lunate and usually subdivided, the central area is larger (i.e. the median rib is farther back) and the posterior area is smaller. The ribs are more clearly defined than in *O. favulata* and the nodes are less conspicuous than in *O. nodosaria.*

Distribution. Typical examples of *O. rimosa* are found in England only in the Portland and lowest Purbeck Beds (Barker 1966a, 1966b) particularly in the Aylesbury area of Buckinghamshire. It has not yet been seen in the Purbeck of the Weald.

Genus STILLINA Laurencich, 1957

The genus *Stillina* was created by Laurencich for a Lower Cretaceous ostracod which resembled *Orthonotacythere* in the character of the radial pore canals and general ornamentation but which differed by having a holomerodont instead of an antimerodont hinge.

The ostracod described below as *Stillina arkelli* is placed in this genus because it has a holomerodont hinge, large ocular tubercles, a ventro-lateral process (in the type species there is a spine in this position), and a caudal process which is shorter than in *S. asterata* Laurencich and more like that found in *Orthonotacythere*, but longer in some individuals than in that figured here, and upturned.

S. arkelli sp. nov. is the only species of this genus so far recognized in the Purbeck or Wealden of England.

Stillina arkelli sp. nov.

Plate XXII, fig. 7

Holotype. GSM Mik(M) 3267001, right valve only. Dimensions: length 0·765 mm, height 0·39 mm. Locality: Warlingham Borehole, Surrey, at 1992 ft 4–6 in. Horizon: Cinder Beds, *C. g. fasciculata* Zone, Middle Purbeck.

Diagnosis. Carapace roughly triangular in lateral view. Anterior with a wide flange bluntly dentate along the dorsal edge. Posterior acute with a small triangular flange. Latero-ventral area produced as a short deep velum which extends ventrally so as to obscure the ventral margin. Shell surface rugged with strong sinuous ribs with reticulate areas between. In the ocular area is a large smooth swelling, behind which is a dorsal sulcus.

Description. S. arkelli differs from all species of the otherwise similar genus *Orthonotacythere* by the size and depth of the lateral velae. It is nearest to *O. cineraria*, a contemporary species, but differs in outline, in the crenulate anterior margin, larger ocular lobe and less pronounced rib pattern. It is not spinose like the Albian *S. asterata* Laurencich and the vela are deeper.

Distribution. Thirty-one individuals of this species have been recovered, all from the Cinder Beds, Middle Purbeck, of the Warlingham Borehole in Surrey and Milkhurst Wood section in Sussex. It has not been seen elsewhere.

Genus PROCYTHEROPTERON Ljubimova, 1955

Procytheropteron barkeri sp. nov.

Plate XXI, figs. 5–6

1966b. *Procytheropteron brodiei:* Barker, p. 477, pl. viii, figs. 23–6; pl. ix, fig. 8.

Holotype. GSM Mik(M) 3304001. Complete carapace, male (Plate XXI, fig. 5). Dimensions: length 0·54 mm, height 0·28 mm, length/height ratio 1·93. Locality: Weedon, Buckinghamshire. Horizon: Lower Purbeck.

Topotype. GSM Mik(M) 3305001. Complete carapace, female (Plate XXI, fig. 6). Dimensions: length 0·44 mm, height 0·265 mm, length/height ratio 1·66. Locality and horizon as holotype.

Diagnosis. A small tumid ovoid carapace with anterior and posterior flanges and ventro-lateral carinae. Surface ornamented with irregular, weak, longitudinal ridges in the ventral half of the shell. Sexual dimorphism well marked.

Description. P. barkeri, first figured by Barker (1966b) as *P. brodiei* (Jones), is very close to that species but is lower and more elongate. The surface ribbing in *P. barkeri* in the ventro-lateral area also distinguishes it from *P. brodiei* in which the surface is only faintly reticulate. The difference in shape between the male and female dimorphs is less obvious in *P. brodiei.*

The ribbed ornament is often difficult to see and only one of Barker's photographs (pl. viii, fig. 26) shows it at all clearly, but reference is made to this feature on his p. 478.

Distribution. All examples of this species so far seen by the writer are from exposures of the Lower Purbeck Beds in the Aylesbury area of Buckinghamshire, i.e. the Bugle Pit, Hartwell; Warren House Farm near Stewkley; Weedon near Whitchurch; Haddenham and Long Crendon.

Procytheropteron brodiei (Jones)

Plate XXI, fig. 7

1894. *Cytheropteron brodiei* Jones, p. 167, pl. ix, figs. 13a–d.
1964. *Procytheropteron brodiei:* Anderson, p. 154, pl. xii, figs. 41–2, 64–6.
non 1966b. *Procytheropteron brodiei:* Barker, p. 477, pl. viii, figs. 23–6; pl. ix, fig. 8.

Lectotype. BM I. 6096, Brodie Collection, a complete female carapace. Dimensions: length 0·45 mm, height 0·30 mm, width 0·32 mm, length/height ratio 1·5. Locality: said to be 'near Bristol' but more probably from the Vale of Wardour. Horizon: said to be 'Rhaetic' but certainly Purbeck, according to the associated fauna.

Figured Specimen. GSM Mik(M) 3306001. A complete carapace, female. Dimensions: length 0·495 mm, height 0·31 mm, length/height ratio 1·6. Locality: Ashdown No. 1 Borehole, Sussex, at 791 ft 10 in to 792 ft 4 in. Horizon: Cinder Beds, *C. g. fasciculata* Zone, Middle Purbeck.

Description. The material from which this species was originally described by Jones in 1894 had been collected by Brodie in 1844, allegedly from the Rhaetic Beds of the Bristol area. Re-examination of the Brodie Collection (Anderson 1964) showed that it contained unmistakable Purbeck ostracods such as *Fabanella boloniensis*, *F. ansata*, *Macrodentina retirugata* and species of

Cypridea. It seems probable that the ostracods described by Jones believing them to be of Rhaetic age were in fact collected in the Vale of Wardour by Brodie when he was searching the Purbeck Beds of that area for fossil insects.

P. brodiei closely resembles the species *Cytheroptina triebeli* and *C. eboracica* described by Neale from the Speeton Clay of Yorkshire (1962, p. 437, pl. iii, fig. 7; pl. iv, figs. 1–4, 5–7; pl. xii, fig. 33). The outline is similar, except that *P. brodiei* is less acute posteriorly, and they all have a faintly reticulate surface ornament. *C. triebeli* is recorded from the Upper Berriasian and *C. eboracica* from the Valanginian.

P. brodiei is distinguished from *Cytheropteron decoratum* Schmidt (1954, p. 82, pl. 5, figs. 1–2; pl. 7, figs. 16–8), *C. impressum* Wolburg (1949, p. 352, pl. ii, fig. 10) and *C. aquitanum* Donze (1960, p. 21, pl. iv, figs. 48–51) in that they have deeper latero-ventral velae and are less symmetrical in outline.

Distribution. P. brodiei is characteristic of the Cinder Beds and the beds immediately above and below in the Middle Purbeck as found in the Milkhurst and Nine Acre Wood sections in Sussex and the Warlingham Borehole in Surrey. It ranges from the Peveril Cycle to the Nothe Cycle.

Family CYTHERIDEIDAE Sars, 1925

Genus GALLIAECYTHERIDEA Oertli, 1957

Galliaecytheridea postsinuata Wolburg

Plate XX, figs. 4–5

1962a. *Galliaecytheridea postsinuata* Wolburg, p. 219, pl. xxxii b, figs. 4–5.

Figured Specimens. GSM Mik(M) 3262001, female right valve only (Plate XX, fig. 4). Dimensions: length 0·99 mm, height 0·57 mm. Locality: Lower Chicksgrove, Vale of Wardour, Wiltshire. Horizon: Middle Purbeck.

GSM Mik(M) 3263001, complete male carapace (Plate XX, fig. 5). Dimensions: length 1·14 mm, height 0·62 mm. Locality: Henfield No. 1 Borehole, Sussex, at 1291 to 1293 ft. Horizon: Burwash Cycle, *C. g. granulosa* Zone, Middle Purbeck.

Description. This species, first figured by Wolburg (1949) as 'Ostracode G56 "sinuat" ' is reported as occurring in Germany in the upper half of 'Wealden' 2 and the lower part of 'Wealden' 3. In England it is commonest in the Cinder Beds, i.e. at or near the base of 'Wealden' 1, but it has been found in several of the more saline bands of the Lower and Middle Purbeck. As Wolburg has pointed out, sexual dimorphism is very well marked in this species.

Distribution. G. postsinuata has been found in England in and about the horizon of the Cinder Beds of the Middle Purbeck (Durlston to Croydon cycles), occasionally at lower horizons (Penshurst and Burwash cycles) and rarely as high as the Poxwell Cycle in the Warlingham Borehole, Surrey; in the Ashdown No. 1, Mountfield No. 3 and Henfield No. 1 boreholes, in the Goldspur Drift and in the Nine Acre Wood, Milkhurst Wood and River Line sections in Sussex; in the Portsdown No. 1 and Chilcomb Down No. 1 boreholes in Hampshire; and in the Arreton Borehole in the Isle of Wight.

Family LIMNOCYTHERIDAE Klie, 1938

Genus BISULCOCYPRIS Pinto and Sanguinetti, 1958

Bisulcocypris dilatata sp. nov.

Plate XIX, figs. 4–5

Holotype. GSM Mik(M) 3300001, complete carapace. Dimensions: length 0·54 mm, height 0·345 mm, width 0·31 mm. Locality: Mountfield No. 4 Borehole, at 313 ft 6 in, Sussex. Horizon: Netherfield Cycle, *C. g. granulosa* Zone, Middle Purbeck.

Diagnosis. Carapace ovoid in lateral view, elliptical from above, almost circular from behind. A shallow dorsal sulcus just anterior to the centre of the shell. Narrow flange along anterior margin. Surface punctate, changing to reticulate ventrally where the punctations are arranged longitudinally and parallel to the ventral margin. In the right valve the hinge consists of an anterior and posterior flange-like tooth joined by a longitudinal groove. In the left valve are corresponding elongate sockets joined by an adont bar which has a narrow accommodation groove dorsal to it. The left valve is only a very little larger than the right.

Description. This small, rather featureless, tumid shell appears to be related to *B. striata* (Martin) but is without the lateral carinae and the postero-dorsal angle is rounded instead of acute. No anterior sulcus can be detected and the posterior sulcus is very shallow and can only be seen under oblique lighting.

Distribution. This species ranges through the Lower and Middle Purbeck (Robertsbridge to Peveril cycles) up to the base of the Cinder Beds but is not very common except in some of the more saline phases. It has been recovered from the Henfield No. 1 and Mountfield No. 4 boreholes and the Milkhurst Wood and Nine Acre Wood sections in Sussex; and from Durlston Bay, the Poxwell Road Cutting and Friar Waddon in Dorset.

Bisulcocypris striata (Martin)

1940. *Gomphocythere striata* Martin, p. 342, pl. vii, figs 101–4; pl. xii, fig. 174.
1940. *Gomphocythere silvana* Martin, p. 345, pl. vi, figs. 87–8; pl. ix, figs. 144–7; pl. xii, fig. 175.
1949. *Gomphocythere silvana:* Wolburg, p. 352, pl. ii, fig. 8.
1962. *Bisulcocypris striata:* Pinto and Sanguinetti, p. 50, pl. v, figs. 5–10; pl. xiii, figs. 5a–d.
1962. *Bisulcocypris striata:* Wolburg, p. 221, pl. xxxiib, figs. 10–1.
1962a. *Bisulcocypris silvana:* Wolburg, p. 221, pl. xxxiib, figs. 12–3.

Holotype. SMF X/E 388. Dimensions: length 0·86 mm, height 0·46 mm. Locality: Bohrung Thören WA 1, Germany, at 772 m. Horizon: 'Wealden' (probably equivalent to a horizon in the English Purbeck just above the Cinder Beds).

Diagnosis. Carapace sub-rectangular in lateral view, triangular from above, pentagonal from behind. An anterior flange. Postero-dorsal angle acute, sometimes extended into a short spine. In the anterior half of the shell two sulci extend downwards from the dorsum almost to the mid-line. A shallow depression ventral to the posterior sulcus contains the adductor muscle scars. Shell surface

coarsely reticulate except on the flange. Reticulations arranged in longitudinal rows ventrally, the costae between forming longitudinal ribs one of which in the male forms a strong carina.

Description. Martin (1940) described two very similar forms as *Gomphocythere striata* and *G. silvana.* Both these are fairly common in the English Purbeck and both show a considerable degree of variation. The lateral carinae may be strongly developed as in *G. striata* or almost absent as in some examples of *G. silvana.* In some individuals the carinae are strongest towards the posterior end, in others they are relatively uniform along their length. In *G. striata* some individuals possess a low tubercle above the posterior end of the carinae, in others, those nearest to *G. silvana,* the tubercle is missing. Both these forms occur together.

Pinto and Sanguinetti (1962) did not consider that these two species should be allocated to the living genus *Gomphocythere* and transferred them to a new genus *Bisulcocypris.* Moreover they expressed the opinion that *silvana* was a juvenile form of *striata.* Measurement of specimens from the English Purbeck does not support this suggestion, since the *silvana*-type shells are not consistently smaller than the *striata*-type. It is much more likely that these two forms are sexual dimorphs and that *silvana* is the female form of *striata.* This kind of dimorphism is in accord with that seen in the related genus *Theriosynoecum* where the males are more strongly ornamented than the females.

In 1962 Wolburg illustrated four different forms as: *B. striata* female (pl. xxxiib, fig. 10); *B.striata* male (pl. xxxiib, fig. 11); *B.silvana* male (pl. xxxiib, fig. 12), a form very like that figured here as a juvenile of *B. striata* (Plate XIX, fig. 2); and *B. silvana* female (pl. xxxiib, fig. 13), the form here separated as a new subspecies *monotuberculata* (Plate XIX, figs. 1, 3).

Distribution. The type of *B. striata* came from the Thören Borehole at a horizon not far above the Cinder Beds of the Middle Purbeck, and that of *B. silvana* from the Rodewald Borehole at a horizon in the Upper Purbeck (Martin 1940, table 13). In England *B. striata striata* is first seen in the Hard Cockle Cycle of the Lower Purbeck and becomes abundant in the strata just below and just above the Cinder Beds, and is also a common species in the upper part of the Middle Purbeck and the lower part of the Upper Purbeck. *B. striata monotuberculata* has a more restricted range, first appearing in the Studland Cycle, and is then fairly common up to the Mupes Cycle. Both subspecies are found, but rarely, in the highest Purbeck Beds and the lower part of the Wealden.

B. striata s.l. has been recovered from the Warlingham Borehole in Surrey; the Mountfield Nos. 3 and 4, Guestling Nos. 1 and 3, Netherfield Place Nos. 3 and 5, Ashdown No. 1, Penshurst (1899) and Henfield No. 1 boreholes and the Goldspur Drift, Milkhurst Wood and Nine Acre Wood sections in Sussex; the Kingsclere No. 1 and Chilcomb Down No. 1 boreholes in Hampshire; and the Durlston Bay section in Dorset.

Bisulcocypris striata striata (Martin)

Plate XIX, fig. 2

Holotype. As for species.

Figured Specimen. GSM Mik(M) 3298001, juvenile left valve. Dimensions: length 0·615 mm, height 0·35 mm. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1758 ft. Horizon: Tisbury Cycle, Upper Purbeck.

Diagnosis. As for species. The subspecies includes two dimorphs, male with the characteristics of the holotype of *B. striata* Martin, and female with the characters of the holotype of *B. silvana* Martin.

Bisulcocypris striata monotuberculata subsp. nov.

Plate XIX, figs. 1, 3

Holotype. GSM Mik(M) 3297001, male carapace (Plate XIX. fig. 1). Dimensions: length 0·735 mm, height 0·44 mm. Locality: Kingsclere No. 1 Borehole, Hampshire, at 1382 ft. Horizon: Lulworth Cycle, Upper Purbeck.

Figured Specimen. GSM Mik(M) 3299001, female left valve (Plate XIX, fig. 3). Dimensions: length 0·73 mm, height 0·43 mm. Locality: Chilcomb Down No. 1 Borehole, Hampshire, at 1758 ft. Horizon: Tisbury Cycle, Upper Purbeck.

Diagnosis. A form of *B. striata* with a low, bluntly conical tubercle in the postero-median area. The male dimorph with ventral carinae, the female without.

Genus STENESTROEMIA Christensen, 1968

Stenestroemia cressida sp. nov.

Plate XXI, fig. 13

Holotype. GSM Mik(M) 2402001, a complete carapace. Dimensions: length 0·555 mm, height 0·29 mm, width 0·23 mm. Locality: Kingsclere No. 1 Borehole, Hampshire, at 996 ft. Horizon: Grinstead Cycle, Grinstead Clay, *Cypridea aculeata* Zone, Wealden.

Diagnosis. A species of the genus *Stenestroemia* in which the shell surface is covered with large subcircular punctations which leave between them a reticulate pattern of ribs. In the ventral area the ribs are more or less parallel to the ventral margin.

Description. The surface ornament in *S. cressida* distinguishes it from *S. fragilis* (Martin), in which the shell is virtually smooth, and from *S. decipiens* (Anderson) in which the ornament consists of closely-set sinuous transverse ribs.

Distribution. This rare species is so far only known from the Grinstead Cycle of the Grinstead Clay as seen in the Kingsclere No. 1 Borehole, Hampshire.

Stenestroemia decipiens (Anderson)

Plate XXI, fig. 12

1941. *Cytherella? decipiens* Anderson, p. 380, pl. xix, figs. 20–1.
1966b. *Dicrorygma decipiens:* Barker, p. 479, pl. vii, figs. 15–6.
1966. *Stenestroemia decipiens:* Christensen, p. 466.
1968. *Stenestroemia decipiens:* Christensen, p. 41.

Holotype. GSM Mik(M) 735001 (formerly GSM 70355), left valve. Dimensions: length 0·47 mm, height 0·25 mm. Locality: Upper Pebbly Beds, Town Gardens Quarry, Swindon, Wiltshire. Horizon: ?basal Purbeck.

Description. This very rare species is characterized by an ornament consisting of narrow discontinuous ridges separated by rows of small pits and running more or less parallel to the ventral margin.

In 1941 very little material was available and the difference in shape, and to a less extent of the ornament of the two valves, made it uncertain that they should be allocated to the same species. Only four separated valves were then known, but Barker (1966b) found three more valves in the Bugle Pit, Aylesbury, at much the same horizon as that from which the Swindon specimens were obtained. More recently a single left valve was recovered from a section in the Darvel Stream near Brightling, Sussex, in the Hard Cockle Cycle, and Christensen (1966, p. 466; 1968, p. 41) has recorded the species from the Lower Purbeck of Bornholm and Scania.

Sufficient material is not yet available to be able to explain the difference in outline and ornament between the two valves, which in all cases were found separated, but it is possible as Christensen has suggested that sexual dimorphism may be the cause.

Distribution. This species is so rare that its occurrence can have little stratigraphical significance; so far it has only been found in the Lower Purbeck.

Stenestroemia fragilis (Martin)

Plate XXI, fig. 11

1940. *Limnocythere fragilis* Martin, p. 348, pl. vii, figs. 105–9; pl. ix, fig. 152.
1966b. *Dicrorygma fragilis:* Barker, p. 479, pl. vii, figs. 19–20.
1968. *Stenestroemia vitabaekensis* Christensen, p. 39, figs. 11c, 13a–c.

Holotype. SMF X/E 777. Dimensions: length 0·86 mm, height 0·42 mm. Locality: Bohrung Rodewald WA 11, Germany, at 401·5 m. Horizon: Lower Serpulit.

Figured Specimen. GSM Mik(M) 3289001, complete carapace. Dimensions: length 0·61 mm, height 0·27 mm, width 0·23 mm. Locality: Durlston Bay, Dorset. Horizon: Cinder Beds, *C. g. fasciculata* Zone, Middle Purbeck.

Description. This species is comparatively rare in the English Purbeck Beds. It is mostly found in the more saline phases such as the Cinder Beds of the Middle Purbeck. Martin's illustrations (1940, pl. vii) show that there is considerable variation in outline, some of which may be due to sexual dimorphism as Christensen has suggested (1968, p. 39), and English examples also display differences in surface texture which appear to be largely due to mode of preservation.

Martin's form figured in pl. vii, fig. 105 from a horizon equivalent to that of the Hard Cockle Cycle in England is that found most commonly in the lowest Purbeck Beds and has been illustrated by Barker from the Bugle Pit near Aylesbury in Buckinghamshire (1966b, pl. vii, figs. 19–20). The majority of examples from higher horizons resemble Martin's pl. vii, figs. 106–7.

Recently Christensen (1968, p. 39) claimed that the form figured by Barker as *Dicrorygma fragilis* (Martin) (1966b, pl. vii, figs. 19–20) belongs to his new species *Stenestroemia vitabaekensis*. While agreeing that Barker's specimens should be included in the genus *Stenestroemia* and not *Dicrorygma* Poag, the specific allocation appears to have been correct. It is true that the specimen figured by Barker is only 0·47 mm long compared with the type which has a length of 0·86 mm, but juveniles have been found. In the material examined by the present writer lengths ranged from 0·5 to 0·725 mm and no specimens were as large as the German examples.

On balance the resemblances between *S. vitabaekensis* Christensen and *Limnocythere fragilis* Martin appear to be more important than the differences and it is suggested that these two names are synonyms. The holotype of *S. vitabaekensis* in particular (Christensen, 1968, figs, 11c, 13c) and the specimen illustrated in his figs. 11a, 13a, are very close to *L. fragilis*. Several individuals resembling Christensen's figs. 11b, 13b have been found but they were all crushed specimens.

Barker (1966b, p. 479) and Christensen (1968, p. 40) have both stated that the shell surface is smooth. In many individuals this appears to be the case but in well-preserved material the surface is seen to be very closely and finely punctate.

Several specimens have been found in which the carapace bears a number of irregular and poorly defined nodes. These may represent a distinct subspecies but the shell substance is so thin that undamaged and undistorted individuals are rarely found, and the nodose forms are not stratigraphically distinct.

Distribution. S. fragilis has been found throughout the English Purbeck ranging from the lowest beds as seen in the Aylesbury district of Buckinghamshire to the Battle Cycle of the Upper Purbeck, but it is most abundant in the Cinder Beds of the Middle Purbeck. The species was present in the Warlingham Borehole in Surrey; the Brightling No. 27, Ashdown No. 1, Penshurst (1899), Mountfield Nos. 3 and 4, Guestling Nos. 1 and 3, Netherfield Place Nos. 3 and 5 boreholes and in the Goldspur Drift, Milkhurst Wood, Nine Acre Wood and Binglett's Wood sections in Sussex; and in the Durlston Bay section in Dorset.

Genus THERIOSYNOECUM Branson, 1936

Theriosynoecum forbesii (Jones)

Plate XXII, figs. 8–11

1885b. *Metacypris forbesii* and var. *verrucosa* Jones, p. 345, pl. viii, figs. 11–6.
1940. *Metacypris forbesii:* Martin, p. 336, pl. vi, figs. 89–94.
1957. *Gomphocythere forbesii forbesii:* Wicher, p. 270.
1962. *Bisulcocypris forbesii*, Pinto and Sanguinetti, p. 39, pl. iii, figs. 1–4; pl. xii, figs. 1a–d.
1962. *Bisulcocypris verrucosa:* Pinto and Sanguinetti, p. 61, pl. viii, figs. 1–4; pl. xvi, figs. 1a–d.
1966b. *Theriosynoecum forbesii:* Barker, p. 480, pl. vii, fig. 6; pl. ix, figs. 11–2.

Lectotypes. Metacypris forbesii Jones, BM In. 39021 (Jones 1885b, pl. viii, fig. 16) female right valve only. Dimensions: length 0·82 mm. Locality: Ridgeway, Dorset. Horizon: Purbeck. *Metacypris forbesii* var. *verrucosa* Jones, BM In. 39020 (Jones 1885b, pl. viii, fig. 14) male. Dimensions: length 0·72 mm. Locality: Mewps (Mupes) Bay, Dorset. Horizon: Purbeck.

Figured Specimens. GSM Mik(M) 3293001, complete carapace (Plate XXII, fig. 8). Dimensions: length 0·87 mm, height 0·6 mm. Locality: Friar Waddon, Dorset. Horizon: Middle Purbeck Chert Bed.

GSM Mik(M) 3294001, complete carapace (Plate XXII, fig. 9). Dimensions: length 0·78 mm, height 0·495 mm. Locality: Ridgeway, Dorset. Horizon: Middle Purbeck.

GSM Mik(M) 3295001, complete carapace (Plate XXII, fig. 10). Dimensions: length 0·81 mm, height 0·5 mm. Locality: Ridgeway, Dorset. Horizon: Middle Purbeck.

GSM Mik(M) 3296001, complete carapace (Plate XXII, fig. 11). Dimensions: length 0·82 mm, height 0·47 mm. Locality: Ridgeway, Dorset. Horizon: Middle Purbeck.

The three last-named specimens were formerly on the slab, GSM 56501, that yielded the lectotype of *Cypridea posticalis* Jones (p. 77) and may therefore have been seen by him.

Description. This species is easily recognized from Jones's original description and figures. Whether it should be allocated to the genus *Bisulcocypris* or to *Theriosynoecum* is debatable (see Sohn and Anderson 1964) but it certainly appears to have affinities with the species *T. fittoni* (Mantell) and *T. alleni* (Pinto and Sanguinetti). Characteristically the dorsal sulcus typical of the genus is often poorly developed. The shell surface is generally coarsely punctate or even reticulate with the punctations arranged in rows which ventrally are parallel to the ventral margin so that the venter appears to be striated. Some specimens bear two small tubercles near the posterior margin and a few (var. *verrucosa*), thought to be males, have a tuberculate pattern not unlike that of *T. fittoni*. Using the numeration adopted for that species (Sohn and Anderson 1964, p. 80) the largest and most persistent tubercles are, C (median anterior), Fa, Fb and E (a vertical row behind the sulcus), h (median posterior), and g (postero-ventral). Usually present but small are B (antero-dorsal) and the two marginal posterior tubercles. In addition a small tubercle may be sometimes seen in position i (postero-dorsal) and D (ventral to the sulcus) which in *T. fittoni* also are usually small. Rare individuals are found in which the tubercular ornament is sparse like that in Plate XXII, fig. 9 where only Fb is present in addition to the two marginal posterior tubercles.

By analogy with *T. fittoni*, where the female carapace is much less tuberculate than the male, especially in the posterior half, which at the same time is swollen and therefore relatively higher, it is concluded that the two forms of *T. forbesii* are sexual dimorphs. The tuberculate forms are much rarer than the non-tuberculate, but appear to have the same stratigraphical range.

Distribution. T. forbesii is known from the basal Purbeck or Portland–Purbeck passage beds and ranges throughout the Lower Purbeck and Middle Purbeck as far as the Croydon Cycle. It is most abundant in the Middle Purbeck.

Specimens have been recovered from the Warlingham Borehole in Surrey; from the Mountfield No. 3, Guestling Nos. 1 and 3, Netherfield No. 5 and Henfield No. 1 boreholes and the Goldspur Drift and Nine Acre Wood sections in Sussex; from the Chilcomb Down No. 1 and Portsdown No. 1 boreholes in Hampshire; the Durlston Bay and Poxwell sections in Dorset and from various localities in the Aylesbury district of Buckinghamshire (Barker 1966b, p. 480).

Family PROGONOCYTHERIDAE Sylvester-Bradley, 1948

Genus KLIEANA Martin, 1940

Klieana alata Martin

Plate XX, figs. 8–9

1940. *Klieana alata* Martin, p. 323, pl. v, figs. 64–73; pl. xi, figs. 158–61.
1940. Ostracod (602) Wicher, pl. iii, fig. 19.
1962. *Klieana alata:* Klingler, Malz and Martin, p. 178, pl. xxv, fig. 24.
1963. *Klieana alata:* Oertli, p. 22, pl. vii, figs. 53–6.
1963. *Klieana alata:* Christensen, p. 34, text-figs. 9, 10 (pars), pl. v, figs. 1a–g.
1966b. *Klieana alata:* Barker, p. 480, pl. vii, figs. 10–4.
1966. *Klieana alata:* Bielecka and Sztejn, fig. 3.
1968. *Klieana alata:* Christensen, p. 32, figs. 10d–e.

Holotype. SMF X/E 319, a female carapace. Dimensions: length 0·62 mm, height 0·44. The male is given as length 0·70 mm, height 0·34 mm. Locality: Bohrung Thören WA 1, Germany, at 784 m. Horizon: given as Wealden but probably Lower Purbeck.

Figured Specimens. GSM Mik(M) 3275001, a female left valve (Plate XX, fig. 9). Dimensions: length 0·55 mm, height 0·375 mm. Locality: Netherfield Place No. 5 Borehole, Sussex, at 924 ft 2–3 in. Horizon: Goldspur Cycle (base of Middle Purbeck).

GSM Mik(M) 3276001, a complete male carapace (Plate XX, fig. 8). Dimensions: length 0·64 mm, height 0·4 mm. Locality: Netherfield Place No. 5 Borehole, Sussex, at 924 ft 3–4 in. Horizon: Goldspur Cycle (base of Middle Purbeck).

Description. K. alata is a common species in the more saline bands of the English Purbeck. There is much variation in the species quite apart from the marked sexual dimorphism. The reticulation of the shell surface may be weak as in the two specimens figured here, or strong as seen in a specimen in the Sedgwick Museum, Cambridge, which came from the Serpulit (Lower Purbeck) of the Ehra No. 2 Borehole, Germany, at 326–8 m. Again, particularly in individuals from the Robertsbridge and Mountfield cycles, the alae in the male are often produced posteriorly into a blunt tubercle.

Distribution. The type specimen was recorded as being from the 'Wealden' of North Germany but the faunal sequence recorded by Martin in the Thören and Rodewald boreholes (1940) suggests that the type-horizon corresponds to a level in the English Purbeck near the Netherfield Cycle.

The range of *K. alata* in Germany appears to be in beds equivalent to the Lower Purbeck and Middle Purbeck up to the Cinder Beds. In England it is found in the basal Purbeck Beds at Swindon, Wiltshire, and the Aylesbury area of Buckinghamshire (Barker 1966b); throughout the Lower Purbeck Beds of the Weald and ranging up through the Middle Purbeck as far as the Cinder Beds Cycle. It is most abundant at the top of the Lower Purbeck and in the lowest beds of the Middle Purbeck.

K. alata has been recorded from the Rabekke Formation of Bornholm, (Christensen 1963) and from the Vitabäck Beds of Scania (Christensen 1968) both of which are Lower Purbeck in age.

Examples of this species have been recovered from the Mountfield Nos. 3 and 4, Guestling No. 3, Netherfield Place No. 5, Brightling No. 27, Ashdown No. 1 and Warlingham boreholes in the Weald; from the Goldspur Drift in Sussex; the Kingsclere No. 1 Borehole in Hampshire; Swindon in Wiltshire; and the Aylesbury area in Buckinghamshire.

So far *K. alata* has not been found in the Purbeck Beds of Dorset, but Barker has recorded it from Buckinghamshire (1966b, p. 480).

Klieana dictyota sp. nov.

Plate XX, figs. 10–11

Holotype. GSM Mik(M) 3274001, complete carapace. Dimensions: length 0·54 mm, height 0·365 mm, width 0·29 mm. Locality: Penshurst (1938) Borehole, Sussex, at 892 to 902 ft. Horizon: Hard Cockle Cycle, Lower Purbeck.

Diagnosis. A small ovate carapace, highest near the anterior end. A poorly defined anterior flange and a smaller and even less clear posterior flange. Carapace oval when seen from above, in end view shows the ventral margin recessed between two rounded alae. Shell surface very coarsely reticulate except near the margins, which are smooth but for the ventral recessed area which is vaguely ribbed longitudinally. Left valve the larger.

Description. This small species is here placed in the genus *Klieana* on account of the hinge organization which appears to be of that genus. The adductor muscle scars have not been seen. *K. dictyota* is so named because of the similarity of the surface ornament to that of a peach stone, a feature which distinguishes it easily from other members of the genus. The lateral alae so characteristic of *K. alata* Martin and *K. thoracina* sp. nov. are barely noticeable in *K. dictyota.*

Distribution. K. dictyota ranges from the Hard Cockle Cycle of the Lower Purbeck to the Scallop Cycle of the Middle Purbeck. The species has been found in the Warlingham Borehole, Surrey; in the Guestling No. 3, Mountfield Nos. 3 and 4, Netherfield Place No. 5, Ashdown No. 1 and Penshurst (1938) boreholes and the Goldspur Drift, Nine Acre Wood, Milkhurst Wood and River Line sections in Sussex. It has not yet been reported from Dorset or Hampshire.

Klieana thoracina sp. nov.

Plate XX, fig. 6

Holotype. GSM Mik(M) 3286001, complete carapace. Dimensions: length 0·46 mm, height 0·28 mm, width 0·295 mm. Locality: Mountfield No. 3 Borehole, Sussex, at 310 ft. Horizon: Worth Cycle, *C. g. fasciculata* Zone, Middle Purbeck.

Diagnosis. Small triangular-ovate carapace. Anterior end rounded and with a broad flange; posterior end acute and flanged; thoracic area much inflated. The ventral half of the shell is covered with a faint reticulation between very fine anastomosing ribs, dorsally finely and closely punctate. The left valve is the larger.

Description. In shape this species resembles some form of *Eocytheropteron* Alexander but the hingement is that of *Klieana.* The outline of the shell and the surface ornament distinguish *K. thoracina* from all other species of the genus.

Distribution. This species, first seen in the Mountfield Cycle of the Goldspur Drift, ranges up as far as the Weald Cycle. It was found in the Mountfield No. 3 Borehole, Sussex, and in the Durlston Bay section, Dorset; in the Worth Cycle, and in the Nothe Cycle in the Ashdown No. 1 Borehole, Sussex; and in the Kingsclere No. 1 Borehole, Hampshire.

Family SCHULERIDEIDAE Mandelstam, 1959

Genus EOCYTHERIDEA Bate, 1963

Eocytheridea eusarca (Anderson)

Plate XXI, fig. 10

1941. *Cytheridea eusarca* Anderson, p. 376, pl. xix, fig. 15.
1966a. *Paraschuleridea? eusarca:* Barker, p. 457, pl. iv, figs, 2, 8–10.

Holotype. GSM Mik(M) 725001 (formerly GSM 70345). Dimensions: length 1·22 mm, height 0·76 mm. Locality: Town Gardens Quarry, Swindon, Wiltshire. Horizon: *Cythere* Marl, basal Purbeck.

Description. This species, first described from the Lower Purbeck of Swindon in Wiltshire, has also been recorded from the Portland Beds of Dorset (Barker 1966a, p. 457) and has been identified by the writer in material from the Portland–Purbeck Beds of Buckinghamshire.

Barker placed the species in the genus *Paraschuleridea* Swartz and Swain although recognizing its affinities with *Eocytheridea.* Examination of well-preserved material from the Warren House Farm exposure in Buckinghamshire suggests that *Eocytheridea* is probably the genus to which it should be assigned on the basis of similar muscle scar pattern, hingement and pore canals.

Sexual dimorphism is well marked, those regarded as male carapaces tapering behind as in the specimens figured by Barker (1966a, pl. iv, figs. 9 and 10 especially) whereas the presumed female carapaces are higher and more swollen behind the adductor muscle scars (cf. Anderson 1941, pl. xix, fig. 15), see Plate XXI, fig. 10.

Distribution. Though common in the uppermost Portland and basal Purbeck of Dorset, Wiltshire and Buckinghamshire, *E. eusarca* has not yet been recorded from the Weald.

Eocytheridea cf. oleroni (Donze)

Plate XXI, figs. 8–9

1960. *Cyprideis? oleroni* Donze, p. 16, pl. iii, figs. 25–30.

Figured Specimens. GSM Mik(M) 3308001. Left valve, female (Plate XXI, fig. 9). Dimensions: length 0·5 mm, height 0·39 mm. Locality: Warren House Farm, Buckinghamshire. Horizon: basal Purbeck.

GSM Mik(M) 3307001. Right valve, male (Plate XXI, fig. 8). Dimensions: length 0·575 mm, height 0·325 mm. Locality and horizon as before.

Description. Ostracods closely resembling the male of *E. eusarca* but generally smaller and with a more clearly marked and larger anterior flange are frequently found accompanying that species in the Buckinghamshire sections. Their muscle-scar pattern, hingement and distribution of pore canals suggest as in

the case of *E. eusarca* that they should be assigned to the genus *Eocytheridea*. Though smaller than the holotype these forms are tentatively identified as *E. oleroni* (Donze).

Distribution. E. cf. *oleroni* is known from the Portland–Purbeck Beds of Buckinghamshire and Wiltshire, a similar horizon to that of the holotype, but has not yet been recorded from the Weald.

Family UNCERTAIN

Genus TIMIRIASEVIA Mandelstam, 1947

Timiriasevia cf. mackerrowi Bate

Plate XX, figs. 12–13

1965. *Timiriasevia mackerrowi* Bate, p. 756, pl. cxi, figs. 2–12.

Figured Specimens. GSM Mik(M) 3322001, complete carapace (Plate XX, fig. 13). Dimensions: length 0·52 mm, height 0·31 mm, width 0·33 mm. Locality: Mountfield No. 4 Borehole, Sussex, at 329 ft to 329 ft 6 in. Horizon: Goldspur Cycle, *C. g. granulosa* Zone, Middle Purbeck.

GSM Mik(M) 3321001 left valve. (Plate XX, fig. 12), Dimensions: length 0·68 mm, height 0·42 mm. Locality: Worbarrow Bay, Dorset. Horizon: Upper Purbeck.

Description. This small shell with its characteristic striated ornament is found in S-phase sediments throughout most of the Purbeck. Though it would seem unlikely that this form belongs to the same species as those described by Bate (1965) from the Bathonian of Oxfordshire, nevertheless they appear to be identical in shape and ornament and the dimensions fall within the same size range. It is found also as part of a similar assemblage (species of *Bisulcocypris*, *Theriosynoecum*, *Stenestroemia* and *Darwinula*) all of which are here regarded as brackish-water forms.

Distribution. T. cf. *mackerrowi* occurs, sometimes abundantly, at intervals from the Lower Soft Cockle Cycle upwards. It has been recovered from the Mountfield Nos. 3 and 4, Brightling No. 27 and Guestling No. 3 boreholes and the Milkhurst Wood section in Sussex; the Warlingham Borehole in Surrey; the Kingsclere No. 1 Borehole in Hampshire; and the Durlston Bay and Worbarrow Bay sections in Dorset.

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PLATES VII–XXIII
AND EXPLANATIONS

EXPLANATION OF PLATE VII *Page*

FIG. 1. *Cypridea dunkeri dunkeri* Jones. Mik (M) 738001, Middle Purbeck. Osmington Mills, Dorset. × 36 63

FIG. 2. *Cypridea dunkeri inversa* Martin. Mik (M) 3152001, Hard Cockle Cycle, Lower Purbeck. Mountfield No. 4 Borehole, Sussex, at 418 ft. × 39 .. 62

FIG. 3. *Cypridea dunkeri carinata* Martin. Mik (M) 3151001, Goldspur Cycle, *C. g. granulosa* Zone, Middle Purbeck. Mountfield No. 4 Borehole, Sussex, at 331 ft to 331 ft 6 in. × 38 62

FIG. 4. *Cypridea dunkeri papulata* (Anderson). Holotype, Mik (M) 737001, Lower Purbeck.Town Gardens Quarry, Swindon, Wiltshire. × 35 .. 61

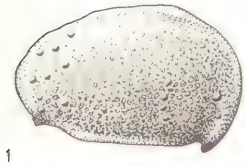
FIG. 5. *Cypridea peltoides peltoides* sp. and subsp. nov. Holotype, Mik (M) 3032001, Mountfield Cycle, Lower Purbeck. Mountfield No. 4 Borehole, Sussex, at 334 to 337 ft. × 34.

FIG. 6. *Cypridea peltoides peltoides* sp. and subsp. nov., elevated form, Mik (M) 3317001, Upper Soft Cockle Cycle, Lower Purbeck. Goldspur Drift, Mountfield, Sussex, at 91 ft 10 in. × 39.

FIG. 7. *Cypridea peltoides peltoides* sp. and subsp. nov., angular form, Mik (M) 3318001, Goldspur Cycle, *C. g. granulosa* Zone, Middle Purbeck. Mountfield No. 4 Borehole, Sussex, at 330 ft 6 in to 331 ft. × 39 .. 76

FIG. 8 *Cypridea peltoides eurygaster* sp. and subsp. nov., depressed form, Mik (M) 3319001. Horizon and locality as fig. 9. × 39.

FIG. 9. *Cypridea peltoides eurygaster* sp. and subsp. nov. Holotype, Mik (M) 3033001, Goldspur Cycle, *C. g. granulosa* Zone, Middle Purbeck. Mountfield No. 4 Borehole, Sussex, at 328 ft 6 in to 329 ft. ×39 .. 76



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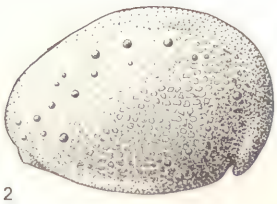

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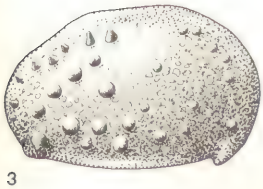

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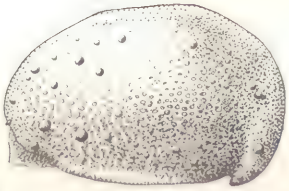

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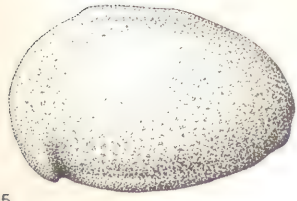

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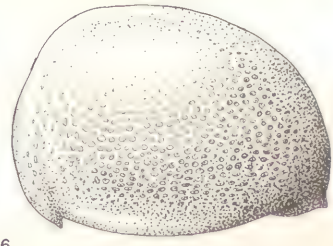

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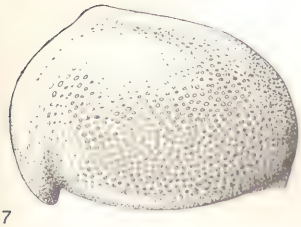

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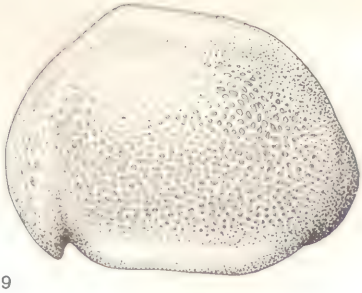

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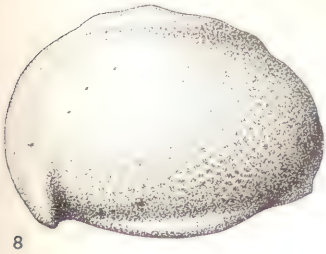

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EXPLANATION OF PLATE VIII *Page*

FIG. 1. *Cypridea tumescens acrobeles* subsp. nov. Holotype, left valve, Mik (M) 3150001, Hard Cockle Cycle, Lower Purbeck. Mountfield No. 4 Borehole, Sussex, at 418 ft. × 40 89

FIG. 2. *Cypridea tumescens praecursor* Oertli. Left valve, Mik (M) 3320001, Goldspur Cycle, *C. g. granulosa* Zone, Middle Purbeck. Mountfield No. 4 Borehole, Sussex, at 329 ft 6 in to 330 ft. × 40 89

FIG. 3. *Cypridea tumescens tumescens* (Anderson). Holotype, left valve, Mik (M) 540001, Durlston Cycle, *C. g. fasciculata* Zone, Middle Purbeck. Friar Waddon, Upwey, Dorset. × 38 90

FIG. 4. *Cypridea swanagensis ornata* sp. and subsp. nov. Holotype, left valve, Mik (M) 3162001, Durlston Cycle, *C. g. fasciculata* Zone, Middle Purbeck. Milkhurst Wood, Sussex. × 39 87

FIG. 5. *Cypridea swanagensis swanagensis* sp. and subsp. nov. Holotype, left valve, Mik (M) 3161001, Durlston Cycle, *C. g. fasciculata* Zone, Middle Purbeck. Milkhurst Wood, Sussex. × 39 86

FIG. 6. *Cypridea posticalis* Jones. Lectotype, left valve, Mik (M) 1020001, Middle Purbeck. Ridgeway, Dorset. × 38 77

FIG. 7. *Cypridea primaeva* Anderson. Left valve, Mik (M) 3153001, Goldspur Cycle, *C. g. granulosa* Zone, Middle Purbeck. Netherfield Place No. 5 Borehole, Sussex, at 924 ft 8–9 in. × 40 78

FIG. 8. *Cypridea darvelensis* sp. nov. Holotype, right valve, Mik (M) 3167001, Scallop Cycle, *C. vidrana* Zone, Middle Purbeck. Warlingham Borehole, Surrey, at 1962 ft 11 in. × 38 57

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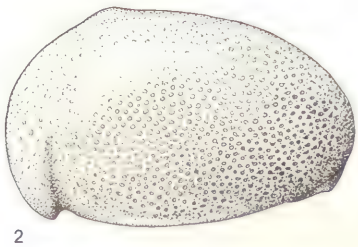

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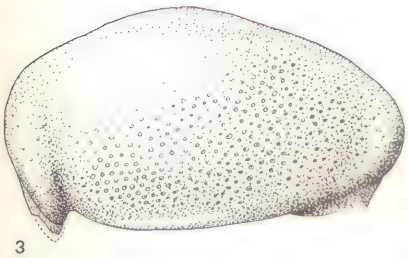

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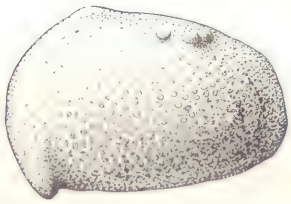

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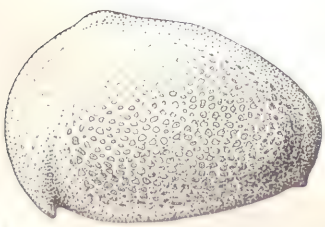

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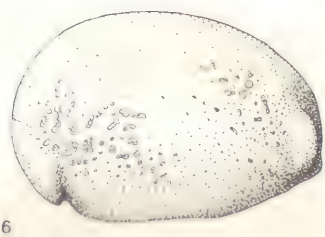

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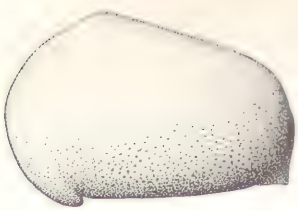

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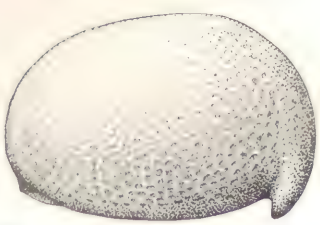

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EXPLANATION OF PLATE IX *Page*

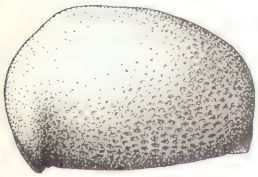
FIG. 1. *Cypridea propunctata* Sylvester-Bradley. Left valve, Mik (M) 3196001, Mupes Cycle, Upper Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1768 ft. × 38.

FIG. 2. *Cypridea propunctata* Sylvester-Bradley. Right valve, Mik (M) 3195001, Brede Cycle, Upper Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1763 ft. × 39 79

FIGS. 3–4. *Cypridea inaequalis* Wolburg. Left and right valves, Mik (M) 3192001, Royal Cycle *C. g. fasciculata* Zone, Middle Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1809 ft. × 38 68

FIGS. 5–6. *Cypridea amisia* Wolburg. Left and right valves, Mik (M) 3211001, Langton Cycle, *C. g. fasciculata* Zone, Middle Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1795 ft. × 38.

FIGS. 7–8. *Cypridea amisia* Wolburg. Left and right valves, Mik (M) 3351001, Royal Cycle, *C. g. fasciculata* Zone, Middle Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1809 ft. × 39 53



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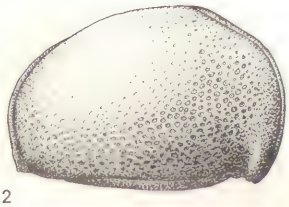

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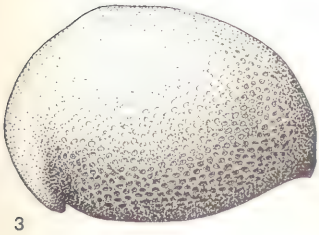

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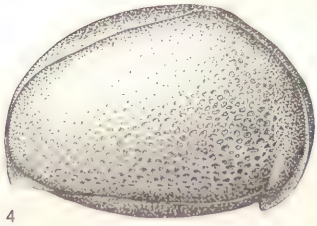

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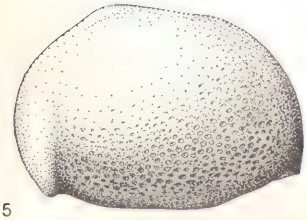

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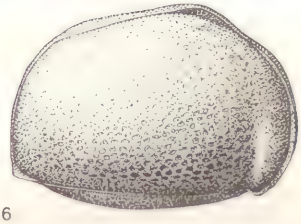

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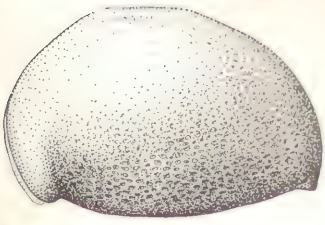

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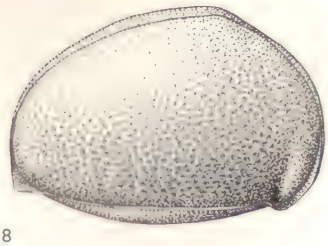

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EXPLANATION OF PLATE X

Page

FIG. 1. *Cypridea sagena* sp. nov. Holotype. Left valve, Mik (M) 3169001, Durlston Cycle, *C. g. fasciculata* Zone, Middle Purbeck. Milkhurst Wood, Sussex. × 38.

FIG. 2. *Cypridea sagena* sp. nov. Large variety, left valve, Mik (M) 3171001, Ashdown Cycle, *C. g. granulosa* Zone, Middle Purbeck. Goldspur Drift, Mountfield, Sussex, at 46 ft 2 in. × 38 80

FIG. 3. *Cypridea vidrana* Wolburg. Left valve, Mik (M) 3181001, Scallop Cycle, *C. vidrana* Zone, Middle Purbeck. Mountfield No. 3 Borehole, Sussex, at 286 ft 6 in. × 38.

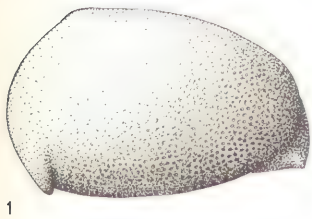
FIG. 4. *Cypridea vidrana* Wolburg. Left valve, Mik (M) 3180001, Scallop Cycle, *C. vidrana* Zone, Middle Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1791 ft. × 38 94

FIG. 5. *Cypridea delicatula* sp. nov. Holotype, right valve, Mik (M) 3170001, Corfe Cycle, *C. g. fasciculata* Zone, Middle Purbeck. Mountfield No. 3 Borehole, Sussex, at 323 ft 6 in. × 39 58

FIG. 6. *Cypridea* cf. *martini* Wolburg. Left valve, Mik (M) 3194001, Brede Cycle, Upper Purbeck. Warlingham Borehole, Surrey, at 1922 ft. × 40 72

FIG. 7. *Cypridea alta alta* Wolburg. Right valve, Mik (M) 3182001, Battle Cycle, Upper Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1737 ft. × 39.

FIG. 8. *Cypridea alta alta* Wolburg. Right valve, Mik (M) 3183001, Battle Cycle, Upper Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1732 ft. × 38 51



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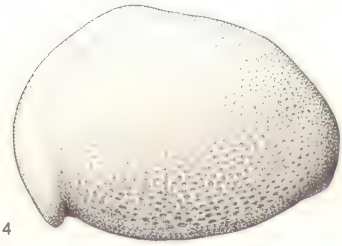

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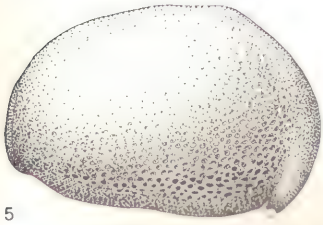

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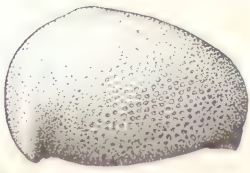

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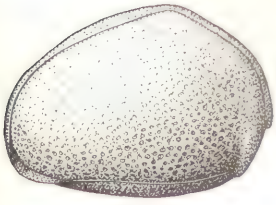

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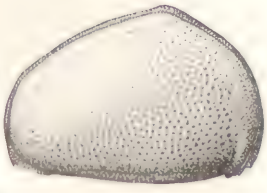

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EXPLANATION OF PLATE XI *Page*

FIG. 1. *Cypridea alta alta* Wolburg. Paralleloid variety, left valve, Mik (M) 3184001, Upper Purbeck. Portsdown No. 1 Borehole, Hampshire, at 2290 to 2295 ft. × 38.

FIG. 2. *Cypridea alta alta* Wolburg. Angulatoid variety, left valve, Mik (M) 3186001, Battle Cycle, Upper Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1732 ft. × 38.

FIG. 3. *Cypridea alta alta* Wolburg. Inflated variety, left valve, Mik (M) 3185001, Tisbury Cycle, Upper Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1753 ft. × 38 51

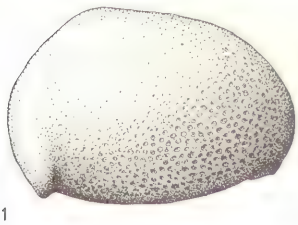
FIG. 4. *Cypridea alta formosa* Wolburg. Left valve, Mik (M) 3187001, Battle Cycle, Upper Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1737 ft. × 40.

FIG. 5. *Cypridea alta formosa* Wolburg. Left valve, Mik (M) 3191001, Mupes Cycle, Upper Purbeck. Warlingham Borehole, Surrey, at 1928 ft. × 39.

FIG. 6. *Cypridea alta formosa* Wolburg. Left valve, Mik (M) 3190001, Lulworth Cycle, Upper Purbeck. Warlingham Borehole, Surrey, at 1931 ft 2 in. × 39.

FIG. 7. *Cypridea alta formosa* Wolburg. Left valve, Mik (M) 3189001, Lulworth Cycle, Upper Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1769 ft. × 37.

FIG. 8. *Cypridea alta formosa* Wolburg. Right valve, Mik (M) 3188001. Horizon and locality as for fig. 7. × 39 52



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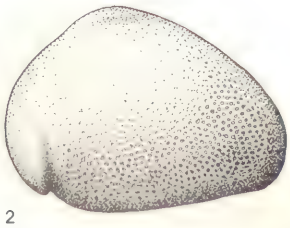

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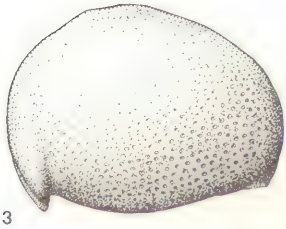

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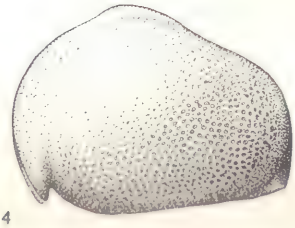

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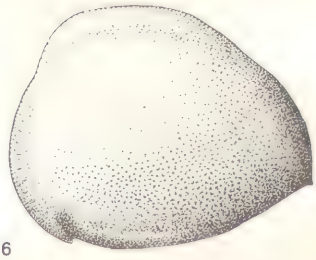

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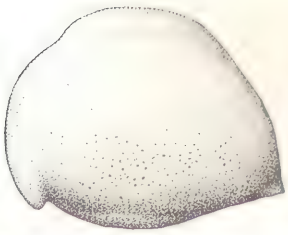

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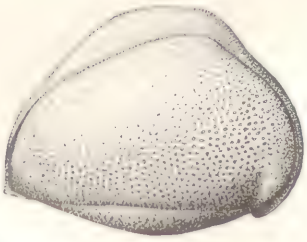

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EXPLANATION OF PLATE XII *Page*

FIG. 1. *Cypridea granulosa protogranulosa* subsp. nov. Topotype, left valve, Mik (M) 3155001, Swanage Cycle, *C. g. granulosa* Zone, Middle Purbeck. Netherfield Place No. 5 Borehole, Sussex, at 907 ft 11 in to 908 ft. × 39.

FIG. 2. *Cypridea granulosa protogranulosa* subsp. nov. Holotype, left valve, Mik (M) 3154001. Horizon and locality as fig. 1. × 39 66

FIG. 3. *Cypridea granulosa granulosa* (J. de C. Sowerby). Lectotype, right valve, Mik (M) 517001, Middle Purbeck. Between Dallard's Farm and Catherine Ford, Vale of Wardour, Wiltshire. × 38.

FIG. 4. *Cypridea granulosa granulosa* (J. de C. Sowerby). Left valve, Mik (M) 3156001, Durlston Cycle, *C. g. fasciculata* Zone, Middle Purbeck. Netherfield Place No. 5 Borehole, Sussex, at 895 ft 7–8 in. × 38 .. 66

FIG. 5. *Cypridea granulosa fasciculata* (Forbes). Neotype, left valve. Mik (M) 390001, Middle Purbeck. Between Dallard's Farm and Catherine Ford, Vale of Wardour, Wiltshire. × 38.

FIG. 6. *Cypridea granulosa fasciculata* (Forbes). Left valve, Mik (M) 3157001, Nothe Cycle, *C. g. fasciculata* Zone, Middle Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1819 ft. × 38.

FIG. 7. *Cypridea granulosa fasciculata* (Forbes). Left valve, Mik (M) 3158001, Corfe Cycle, *C. g. fasciculata* Zone, Middle Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1805 ft. × 38 67

FIG. 8. *Cypridea altissima* Martin. Left valve, Mik (M) 3301001, Scallop Cycle, *C. vidrana* Zone, Middle Purbeck. Warlingham Borehole, Surrey, at 1962 ft 11 in. × 38 52

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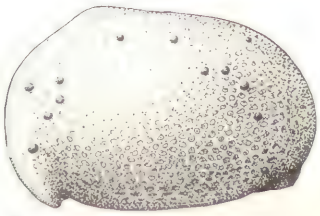

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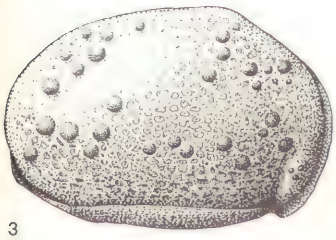

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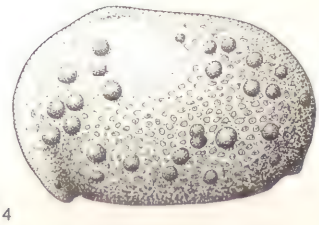

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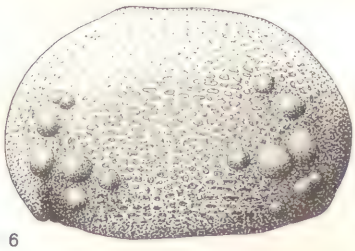

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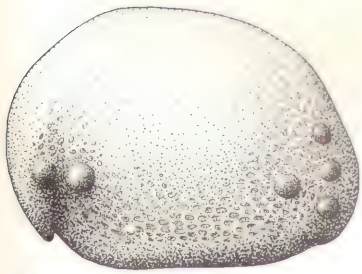

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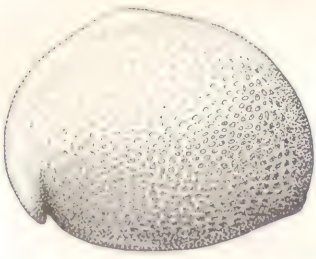

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EXPLANATION OF PLATE XIII *Page*

FIG. 1. *Cypridea altissima* Martin. Left valve, Mik (M) 3159001, Langton Cycle, *C. g. fasciculata* Zone, Middle Purbeck. Mountfield No. 3 Borehole, Sussex, at 297 ft. × 38 52

FIG. 2. *Cypridea varians* sp. nov. Holotype, left valve, Mik (M) 3210001, Battle Cycle, Upper Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1732 ft. × 38 90

FIG. 3. *Cypridea coelnothi* sp. nov. Holotype, left valve, Mik (M) 3160001, Durlston Cycle, *C. g. fasciculata* Zone, Middle Purbeck. Netherfield Place No. 5 Borehole, Sussex, at 893 ft 11 in to 894 ft. × 39 56

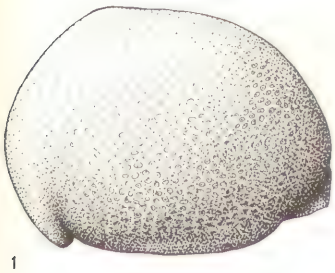
FIG. 4. *Cypridea tuberculata langtonensis* subsp. nov. Holotype, left valve, Mik (M) 3207001, Scallop Cycle, *C. vidrana* Zone, Middle Purbeck. Warlingham Borehole, Surrey, at 1962 ft 11 in. × 38 88

FIG. 5. *Cypridea tuberculata adjuncta* Jones. Left valve, Mik (M) 3208001, ?Hastings Cycle, Hastings Beds, Wealden. Henfield No. 1 Borehole, Sussex, at 1020 to 1025 ft. × 38 87

FIG. 6. *Cypridea ventrosa* Jones. Left valve, Mik (M) 3205001, Upper Purbeck. Peveril Point, Swanage, Dorset. × 38 91

FIG. 7. *Cypridea morula* sp. nov. Holotype, left valve, Mik (M) 2169001, Bexhill Cycle, *C. brevirostrata* Zone, Hastings Beds, Wealden. Chilcomb Down No. 1 Borehole, Hampshire, at 1703 ft. × 38.

FIG. 8. *Cypridea morula* sp. nov. Topotype, right valve, Mik (M) 3163001. Horizon and locality as for fig. 7. × 39 72



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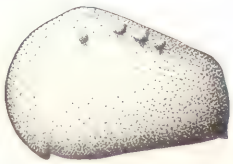

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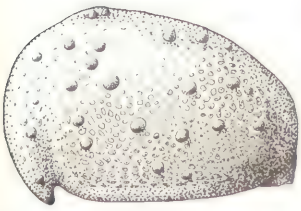

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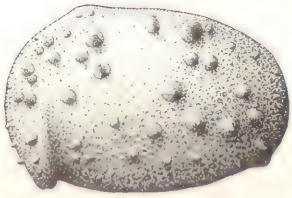

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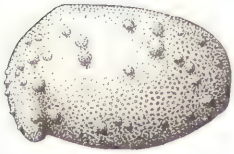

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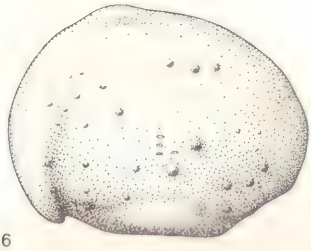

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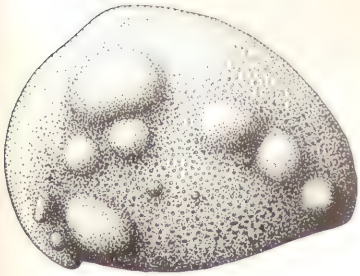

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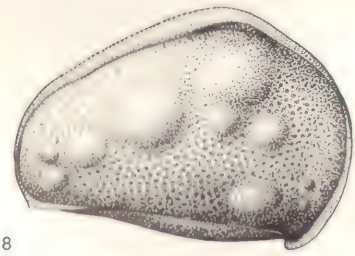

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EXPLANATION OF PLATE XIV *Page*

FIG. 1. *Cypridea wicheri isabellae* subsp. nov. Holotype, left valve, Mik (M) 2166001, Bexhill Cycle, *C. brevirostrata* Zone, Hastings Beds, Wealden. Chilcomb Down No. 1 Borehole, Hampshire, at 1701 ft. × 39 .. 95

FIG. 2. *Cypridea wicheri torosa* subsp. nov. Left valve, Mik (M) 2165001. Horizon and locality as for fig. 1. × 39.

FIG. 3. *Cypridea wicheri torosa* subsp. nov. Left valve, Mik (M) 3164001, Bexhill Cycle, *C. brevirostrata* Zone, Hastings Beds, Wealden. Chilcomb Down No. 1 Borehole, Hampshire, at 1702 ft. × 38 96

FIG. 4. *Cypridea wicheri wicki* Wolburg. Left valve, Mik (M) 3165001, Bexhill Cycle, *C. brevirostrata* Zone, Hastings Beds, Wealden. Chilcomb Down No. 1 Borehole, Hampshire, at 1704 ft. × 38 96

FIG. 5. *Cypridea wicheri wicheri* Wolburg. Left valve Mik (M) 3166001, Bexhill Cycle, *C. brevirostrata* Zone, Hastings Beds, Wealden. Chilcomb Down No. 1 Borehole, Hampshire, at 1700 ft. × 39 97

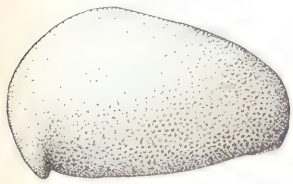
FIG. 6. *Cypridea wicheri wicki* Wolburg. Right valve, Mik (M) 3302001, Mupes Cycle, Upper Purbeck. Warlingham Borehole, Surrey, at 1929 ft 6 in. × 39 96

FIG. 7. *Cypridea wicheri veronae* subsp. nov. Left valve, Mik (M) 3303001. Horizon and locality as for fig. 4. × 39.

FIG. 8. *Cypridea wicheri veronae* subsp. nov. Holotype, left valve. Mik (M) 2162001. Horizon and locality as for fig. 4. × 38 97

FIG. 9. *Cypridea wicheri croesi* subsp. nov. Holotype, left valve. Mik (M) 2160001. Horizon and locality as for fig. 4. × 39 98

FIG. 10. *Cypridea wicheri veronae* subsp. nov. Left valve, Mik (M) 2161001. Horizon and locality as for fig. 4. × 38 97



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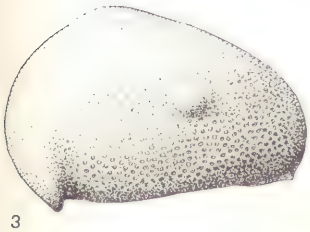

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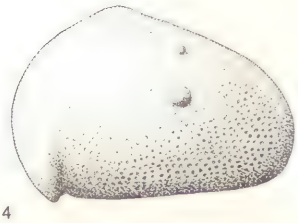

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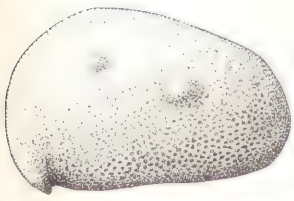

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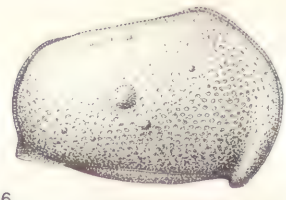

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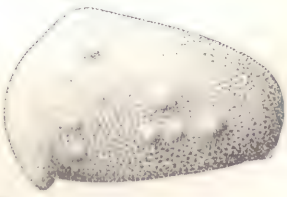

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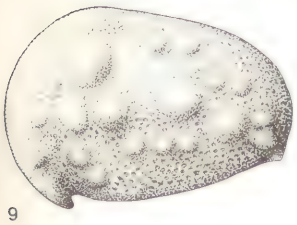

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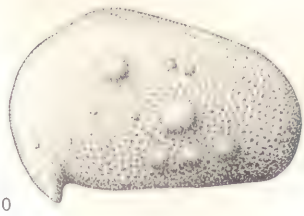

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EXPLANATION OF PLATE XV *Page*

FIG. 1. *Cypridea penshurstensis* sp. nov. Holotype, right valve, Mik (M) 3168001, Mupes Cycle, Upper Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1766 ft. × 38 76

FIG. 2. *Cypridea brevirostrata* Martin. Right valve, Mik (M) 3197001, Worth Cycle, *C. g. fasciculata* Zone, Middle Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1801 ft. × 40 56

FIG. 3. *Cypridea lata lata* Martin. Right valve, depressed variety, Mik (M) 3174001, Durlston Cycle, *C. g. fasciculata* Zone, Middle Purbeck. Goldspur Drift, Mountfield, Sussex, at 23 ft 10 in. × 38.

FIG. 4. *Cypridea lata lata* Martin. Left valve, elevated variety, Mik (M) 3173001, Durlston Cycle, *C. g. fasciculata* Zone, Middle Purbeck. Milkhurst Wood, Sussex. × 39.

FIG. 5. *Cypridea lata lata* Martin. Left valve, Mik (M) 3172001, Durlston Cycle, *C. g. fasciculata* Zone, Middle Purbeck. Nine Acre Wood, Sussex. × 38 70

FIGS. 6–7. *Cypridea lata senilis* subsp. nov. Holotype, right and left valves, Mik (M) 3175001, Poxwell Cycle, *C. vidrana* Zone, Middle Purbeck. Guestling No. 1 Borehole, Sussex, at 902 ft. × 38 70

FIG. 8. *Cypridea lata latissima* subsp. nov. Topotype, right valve, Mik (M) 3178001. Horizon and locality as for fig. 10. × 39 71

FIG. 9. *Cypridea lata senilis* subsp. nov. Left valve, elevated form, Mik (M) 3176001, Studland Cycle, *C. vidrana* Zone, Middle Purbeck. Guestling No. 3 Borehole, Sussex, at 711 ft 1–2 in. × 38 70

FIG. 10. *Cypridea lata latissima* subsp. nov. Holotype, left valve, Mik (M) 3177001, Lulworth Cycle, Upper Purbeck. Kingsclere No. 1 Borehole, Hampshire, at 1385 ft. × 39 71

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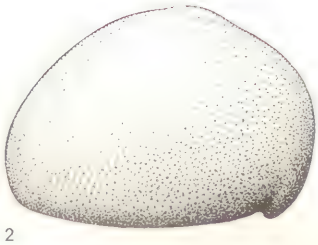

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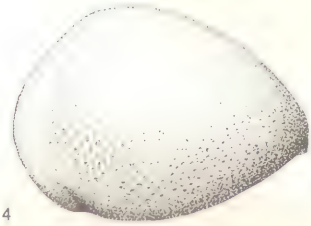

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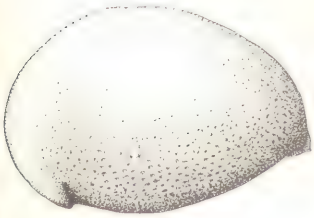

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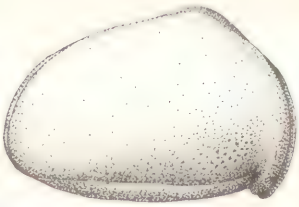

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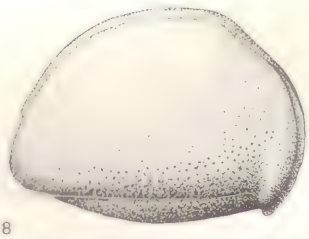

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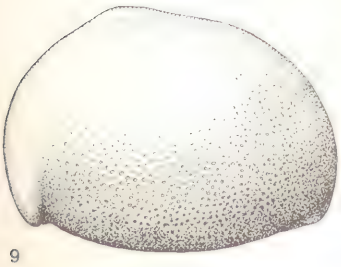

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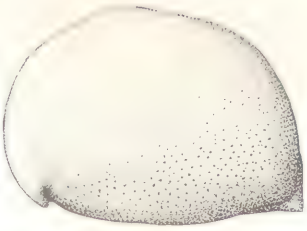

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EXPLANATION OF PLATE XVI *Page*

FIG. 1. *Cypridea lata latissima* subsp. nov. Juvenile left valve, Mik (M) 3179001, Mupes Cycle, Upper Purbeck. Chilcomb Down No 1 Borehole, Hampshire, at 1765 ft. × 39 71

FIG. 2. *Cypridea simplex* sp. nov. Holotype, left valve, Mik (M) 3209001, Tisbury Cycle, Upper Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1755 ft. × 37 85

FIGS. 3–4. *Cypridea wolburgi* sp. nov. Holotype, right and left valves, Mik (M) 3206001, Lulworth Cycle, Upper Purbeck. Warlingham Borehole, Surrey, at 1931 ft 2 in. × 38 99

FIG. 5. *Cypridea acuta* sp. nov. Holotype, right valve, Mik (M) 3198001, Poxwell Cycle, *C. vidrana* Zone, Middle Purbeck. Warlingham Borehole, Surrey, at 1946 ft. 6 in. × 39 50

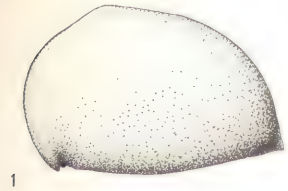
FIG. 6. *Cypridea paulsgrovensis* (Anderson). Right valve, Mik (M) 2156001, St. Leonard's Cycle, *C. paulsgrovensis* Zone, Wadhurst Clay, Wealden. Warlingham Borehole, Surrey, at 1793 ft 6 in. × 39 74

FIG. 7. *Cypridea dolabrata dolabrata* (Anderson). Holotype, left valve, Mik (M) 533001, Upper Purbeck. Portsdown No. 1 Borehole, Hampshire, at 2250 to 2255 ft. × 38 59

FIG. 8. *Cypridea dolabrata angulata* Martin. Left valve, Mik (M) 2126001, *C. brevirostrata* Zone, Hastings Beds, Wealden. Chilcomb Down No. 1 Borehole, Hampshire, at 1687 ft. × 38.

FIG. 9. *Cypridea dolabrata angulata* Martin. Left valve, gibbous variety, Mik (M) 2127001, *C. brevirostrata* Zone, Hastings Beds, Wealden. Chilcomb Down No. 1 Borehole, Hampshire, at 1684 ft. × 40 59

FIG. 10. *Cypridea dolabrata kingsclerensis* subsp. nov. Holotype, left valve, Mik (M) 2125001, *C. brevirostrata* Zone, Hastings Beds, Wealden. Kingsclere No. 1 Borehole, Hampshire, at 1334 ft. × 38 59



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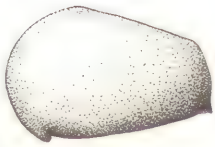

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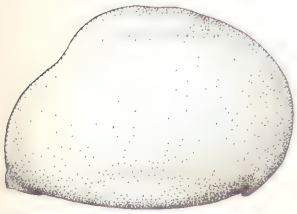

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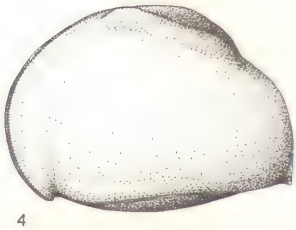

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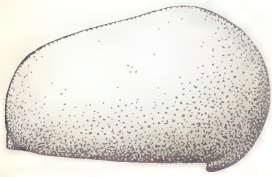

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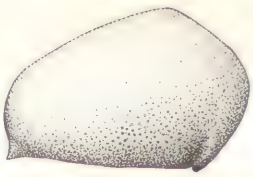

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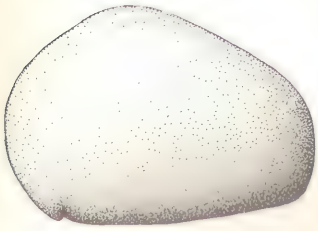

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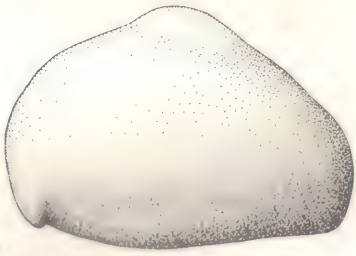

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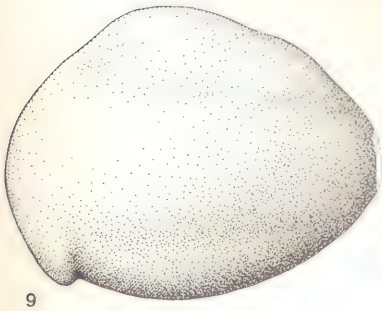

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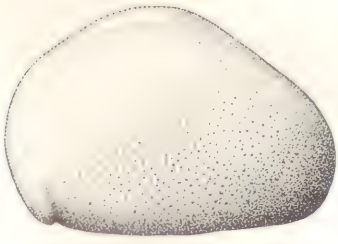

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EXPLANATION OF PLATE XVII *Page*

FIG. 1. *Cypridea setina acerata* Anderson. Holotype, left valve, Mik (M) 3204001, *C. brevirostrata* Zone, Hastings Beds, Wealden. Chilcomb Down No. 1 Borehole, Hampshire, at 1710 ft. × 39 81

FIG. 2. *Cypridea setina bellatula* subsp. nov. Holotype, left valve, Mik (M) 2153001, *C. paulsgrovensis* Zone, Hastings Beds, Wealden. Chilcomb Down No. 1 Borehole, Hampshire, at 1700 ft. × 39.

FIG. 3. *Cypridea setina bellatula* subsp. nov. Left valve, Mik (M) 3203001, *C. paulsgrovensis* Zone, Hastings Beds, Wealden. Chilcomb Down No. 1 Borehole, Hampshire, at 1699 ft. × 39 82

FIG. 4. *Cypridea setina camelodes* Anderson. Holotype, left valve, Mik (M) 3202001, Tyneham Cycle, Upper Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1745 ft. × 39 82

FIG. 5. *Cypridea setina dotica* Anderson. Holotype, left valve, Mik (M) 3311001, Tisbury Cycle, Upper Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1751 ft. × 38.

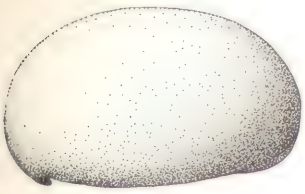
FIG. 6. *Cypridea setina dotica* Anderson. Left valve, Mik (M) 3312001, Durdle Cycle, Upper Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1749 ft. × 38 83

FIG. 7. *Cypridea setina erumna* Anderson. Holotype, left valve, Mik (M) 3313001, Brede Cycle, Upper Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1762 ft. × 39 83

FIG. 8. *Cypridea setina florida* subsp. nov. Topotype, left valve, Mik (M) 3200001, *C. brevirostrata* Zone, Hastings Beds, Wealden. Chilcomb Down No. 1 Borehole, Hampshire, at 1705 ft. × 39 84

FIG. 9. *Cypridea setina rectidorsata* Sylvester-Bradley. Left valve, Mik (M) 3314001, Mupes Cycle, Upper Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1767 ft. × 38 84

FIG. 10. *Cypridea setina setina* Anderson. Left valve, Mik (M) 3315001, Brede Cycle, Upper Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1764 ft. × 39 84



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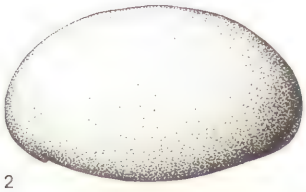

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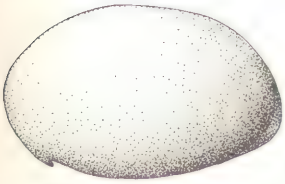

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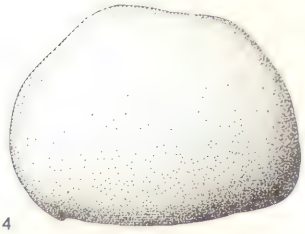

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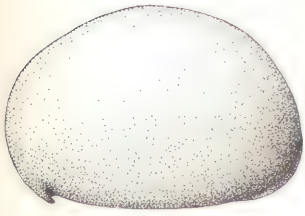

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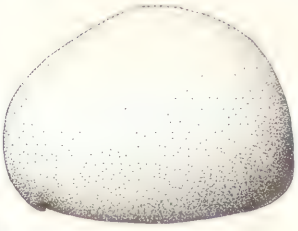

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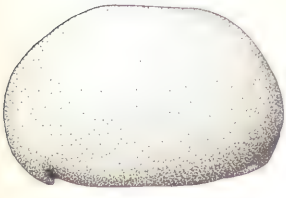

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EXPLANATION OF PLATE XVIII *Page*

FIG. 1. *Cypridea setina deburghi* subsp. nov. Holotype, right valve, Mik (M) 2152001, *C. brevirostrata* Zone, Hastings Beds, Wealden. Chilcomb Down No. 1 Borehole, Hampshire, at 1729 ft. × 40 83

FIG. 2. *Cypridea andersoni* Wolburg. Right valve, Mik (M) 3193001, Worth Cycle, *C. g. fasciculata* Zone, Middle Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1802 ft. × 40 54

FIG. 3. *Cypridea obliqua* Wolburg. Left valve, Mik (M) 3212001. Brede Cycle, Upper Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1764 ft. × 39.

FIG. 4. *Cypridea obliqua* Wolburg. Left valve, Mik (M) 3213001. Horizon and locality as for fig. 3. × 39 73

FIG. 5. *Cypridea bimammata* Harbort, *prolifera* subsp. nov. Holotype, Mik (M) 3325001, Brede Cycle, Upper Purbeck. Mountfield No. 3 Borehole, Sussex, at 206 ft 6 in. × 40 55

FIGS. 6–7. *Scabriculocypris trapezoides* Anderson. Holotype, left and right valves, Mik (M) 727001, *Chara* Marls, Lower Purbeck. Town Gardens Quarry, Swindon, Wiltshire. × 74 101

FIG. 8. *Darwinula leguminella* (Forbes). Left valve, Mik (M) 3323001, Brede Cycle, Upper Purbeck. Mountfield No. 3 Borehole, Sussex, at 205 ft 6 in. × 74 110

FIG. 9. *Darwinula oblonga* (Roemer). Left valve, Mik (M) 3324001, *C. dorsispinata* Zone, Weald Clay, Wealden. Warninglid Borehole, Sussex, at 48 to 49 ft. × 39 111

FIG. 10. *Darwinula jonesi* sp. nov. Holotype, right valve, Mik (M) 3326001, *C. tenuis* Zone, Weald Clay, Wealden. Wateringbury, near Maidstone, Kent. × 40 111

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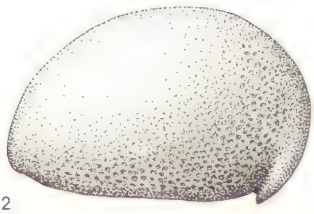

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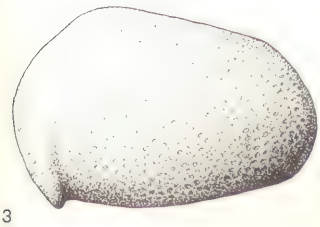

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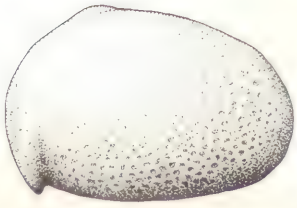

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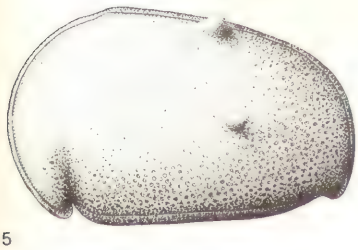

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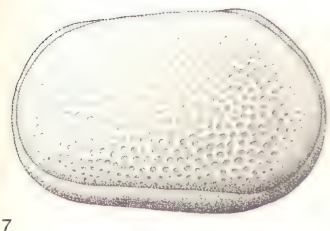

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EXPLANATION OF PLATE XIX *Page*

FIG. 1. *Bisulcocypris striata monotuberculata* subsp. nov. Holotype, male left valve, Mik (M) 3297001, Lulworth Cycle, Upper Purbeck. Kingsclere No. 1 Borehole, Hampshire, at 1382 ft. × 38 126

FIG. 2. *Bisulcocypris striata striata* Martin. Juvenile male left valve, Mik (M) 3298001, Tisbury Cycle, Upper Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1758 ft. × 38 125

FIG. 3. *Bisulcocypris striata monotuberculata* subsp. nov. Female left valve, Mik (M) 3299001. Horizon and locality as for fig. 2. × 38 126

FIGS. 4–5. *Bisulcocypris dilatata* sp. nov. Holotype, left valve and posterior, Mik (M) 3300001, Netherfield Cycle, *C. g. granulosa* Zone, Middle Purbeck. Mountfield No. 4 Borehole, Sussex, at 313 ft 6 in. × 39 124

FIG. 6. *Eoparacypris attenuata* gen. et sp. nov. Holotype, left valve, Mik (M) 3277001, ?Stair Cycle, Lower Purbeck. Henfield No. 1 Borehole, Sussex, at 1424 to 1426 ft. × 28 107

FIG. 7. *Eoparacypris abbreviata* gen. et sp. nov. Holotype, left valve, Mik (M) 3278001, Langton Cycle, *C. g. fasciculata* Zone, Middle Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1787 ft. × 39 .. 107

FIG. 8. *Eoparacypris surriensis* gen. et sp. nov. Holotype, left valve, Mik (M) 3284001, Greenwood Cycle, *C. vidrana* Zone, Middle Purbeck. Warlingham Borehole, Surrey, at 1940 ft 6 in. × 39 109

FIG. 9. *Eoparacypris parallela* (Neale). Right valve, Mik (M) 3283001, Hastings Cycle *C. brevirostrata* Zone, Hastings Beds, Wealden. Chilcomb Down No. 1 Borehole, Hampshire, at 1728 ft. × 40 109

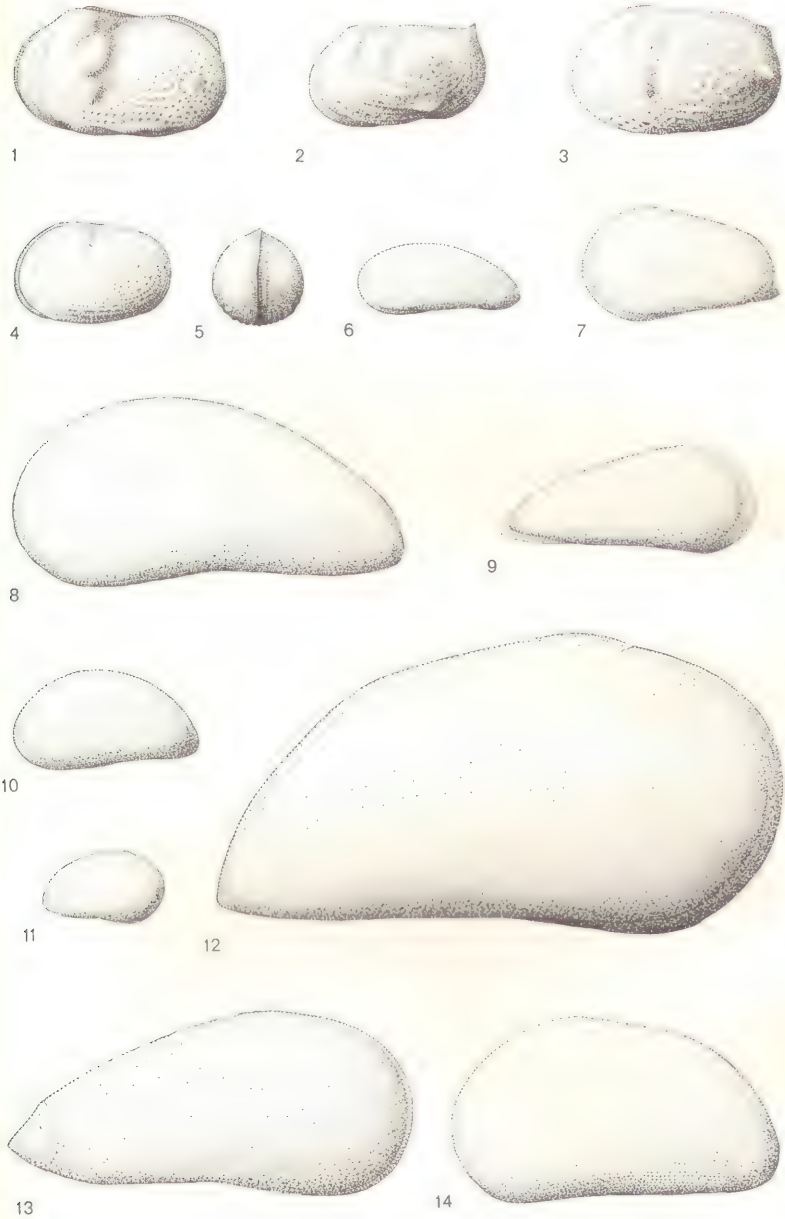
FIG. 10. *Eoparacypris weedonensis* gen. et sp. nov. Holotype, left valve, Mik (M) 3285001, Swanage Cycle, *C. g. granulosa* Zone, Middle Purbeck. Netherfield Place No. 5 Borehole, Sussex, at 907 ft 11 in to 908 ft. × 39 110

FIG. 11. *Eoparacypris edwardi* gen. et sp. nov. Holotype, right valve, Mik (M) 3280001, Fairlight Cycle, *C. paulsgrovensis* Zone, Wadhurst Clay, Wealden. Warlingham Borehole, Surrey, at 1788 ft. × 37 108

FIG. 12. *Eoparacypris macroselina* gen. et sp. nov. Holotype, right valve, Mik (M) 3281001, Tisbury Cycle, Upper Purbeck. Penshurst (1899) Borehole, Sussex, at 629 ft. × 37.

FIG. 13. *Eoparacypris macroselina* gen. et sp. nov. Male right valve, Mik (M) 3288001, Tyneham Cycle, Upper Purbeck. Netherfield Place No. 3 Borehole, Sussex, at 720 ft 0–1 in. × 38 108

FIG. 14. *Pseudoparacypridopsis mountfieldensis* gen. et sp. nov. Holotype, left valve, Mik (M) 3282001, Ashdown Cycle, *C. g. granulosa* Zone, Middle Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1856 ft. × 39 103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EXPLANATION OF PLATE XX *Page*

FIG. 1. *Fabanella boloniensis* (Jones). Left valve, BM I. 1674, ?Lower Purbeck. Hartwell, Buckinghamshire. × 32 113

FIG. 2. *Fabanella dimorpha* sp. nov. Holotype, left valve, Mik (M) 3214001, Lulworth Cycle, Upper Purbeck. Kingsclere No. 1 Borehole, Hampshire, at 1382 ft. × 39 115

FIG. 3. *Fabanella ansata* (Jones). Lectotype, left valve, BM I. 1654, Lower Purbeck. South Oving, Buckinghamshire. × 57 112

FIG. 4. *Galliaecytheridea postsinuata* Wolburg. Female right valve, Mik (M) 3262001, Middle Purbeck. Lower Chicksgrove, Vale of Wardour, Wiltshire. × 37.

FIG. 5. *Galliaecytheridea postsinuata* Wolburg. Male left valve, Mik (M) 3263001, Burwash Cycle, *C. g. granulosa* Zone, Middle Purbeck. Henfield No. 1 Borehole, Sussex, at 1291 to 1293 ft. × 40 123

FIG. 6. *Klieana thoracina* sp. nov. Holotype, right valve, Mik (M) 3286001, Worth Cycle, *C. g. fasciculata* Zone, Middle Purbeck. Mountfield No. 3 Borehole, Sussex, at 310 ft. × 76 131

FIG. 7. *Rhinocypris jurassica* (Martin). Left valve, Mik (M) 3287001, ?Upper Purbeck. Osmington Mills, Dorset. × 71 102

FIG. 8. *Klieana alata* Martin. Male left valve, Mik (M) 3276001, Goldspur Cycle, *C. g. granulosa* Zone, Middle Purbeck. Netherfield Place No. 5 Borehole, Sussex, at 924 ft 3–4 in. × 38.

FIG. 9. *Klieana alata* Martin. Female left valve, Mik (M) 3275001, Goldspur Cycle, *C. g. granulosa* Zone, Middle Purbeck. Netherfield Place No. 5 Borehole, Sussex, at 924 ft 2–3 in. × 38 130

FIGS. 10–11. *Klieana dictyota* sp. nov. Holotype, left and posterior, Mik (M) 3274001, Hard Cockle Cycle, Lower Purbeck. Penshurst (1938) Borehole, Sussex, at 892 to 902 ft. × 74 131

FIG. 12. *Timiriasevia* cf. *mackerrowi* Bate. Left valve, Mik (M) 3321001, Upper Purbeck. Worbarrow Bay, Dorset. × 56.

FIG. 13. *Timiriasevia* cf. *mackerrowi* Bate. Right valve, Mik (M) 3322001, Goldspur Cycle, *C. g. granulosa* Zone, Middle Purbeck. Mountfield No. 4 Borehole, Sussex, at 329 ft to 329 ft 6 in. × 72 133

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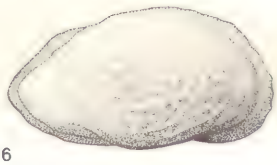

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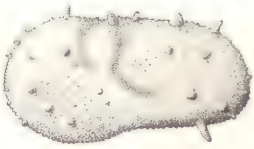

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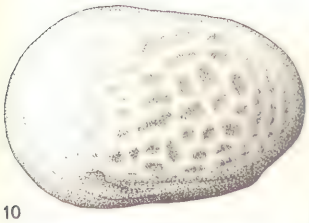

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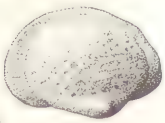

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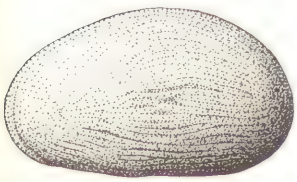

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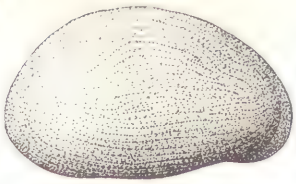

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EXPLANATION OF PLATE XXI *Page*

FIG. 1. *Macrodentina transiens* (Jones). Right valve, Mik (M) 3291001, top Portland or basal Purbeck Beds. Warren House Farm, Stewkley, Buckinghamshire. × 38 118

FIG. 2. *Macrodentina rugulata* (Jones). Right valve, Mik (M) 3290001, top Portland or basal Purbeck Beds. Warren House Farm, Stewkley, Buckinghamshire. × 39 117

FIG. 3. *Macrodentina retirugata* (Jones). Female right valve, Mik (M) 720001, top Portland or basal Purbeck Beds. Town Gardens Quarry, Swindon, Wiltshire. × 39 116

FIG. 4. *Macrodentina mediostricta* (Sylvester-Bradley). Male left valve, Mik (M) 3292001, Middle Purbeck. Milkhurst Wood, Sussex. × 38 116

FIG. 5. *Procytheropteron barkeri* sp. nov. Holotype, male left valve, Mik (M) 3304001, Lower Purbeck. Weedon, Buckinghamshire. × 74.

FIG. 6. *Procytheropteron barkeri* sp. nov. Topotype, female left valve, Mik (M) 3305001. Horizon and locality as for fig. 5. × 75 122

FIG. 7. *Procytheropteron brodiei* (Jones). Female left valve, Mik (M) 3306001, Cinder Beds Cycle, *C. g. fasciculata* Zone, Middle Purbeck. Ashdown No. 1 Borehole, Sussex, at 791 ft 10 in to 792 ft 4 in. × 73 122

FIG. 8. *Eocytheridea* cf. *oleroni* (Donze). Male right valve, Mik (M) 3307001, Lower Purbeck. Warren House Farm, Stewkley, Buckinghamshire. × 38.

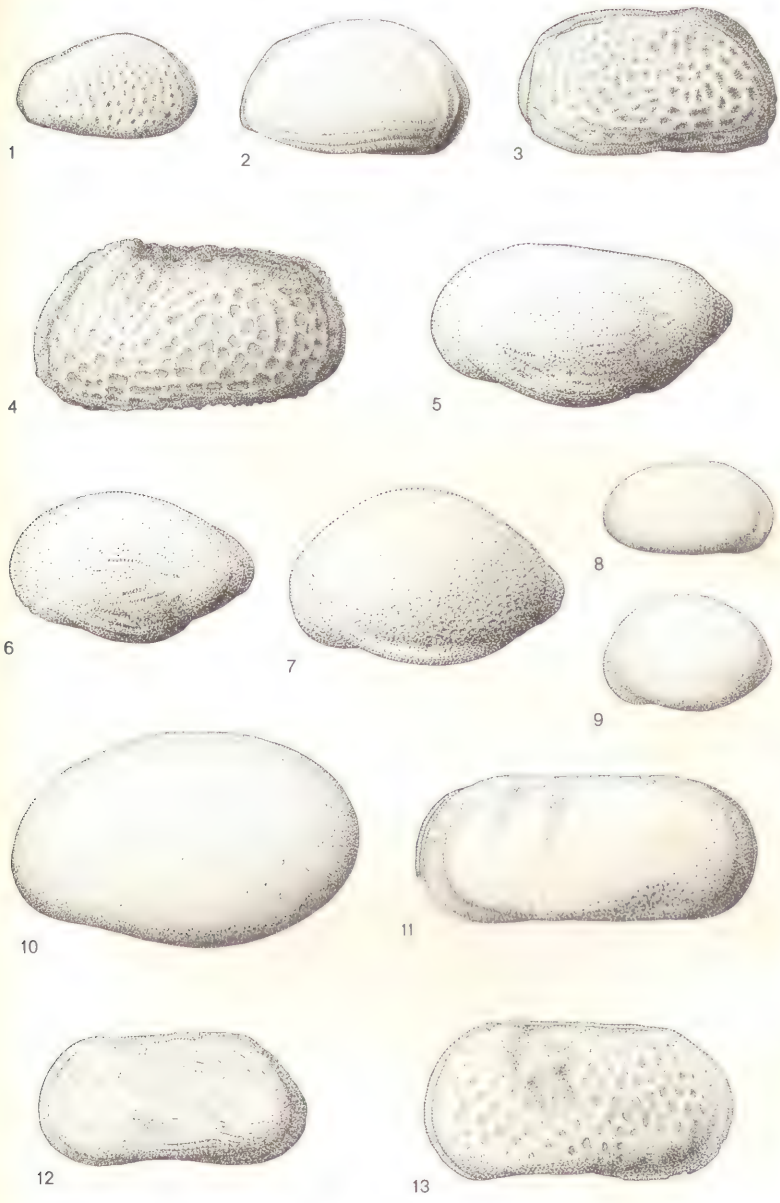
FIG. 9. *Eocytheridea* cf. *oleroni* (Donze). Female left valve, Mik (M) 3308001, Lower Purbeck. Warren House Farm, Stewkley, Buckinghamshire. × 44 132

FIG. 10. *Eocytheridea eusarca* (Anderson). Holotype, left valve, Mik (M) 725001, '*Cythere*' Marl, Lower Purbeck. Town Gardens Quarry, Swindon, Wiltshire. × 38 132

FIG. 11. *Stenestroemia fragilis* (Martin). Left valve, Mik (M) 3289001, Cinder Beds Cycle, *C. g. fasciculata* Zone, Middle Purbeck. Durlston Bay, Dorset. × 74 127

FIG. 12. *Stenestroemia decipiens* (Anderson). Holotype, left valve, Mik (M) 735001, Upper Pebbly Beds, Lower Purbeck. Town Gardens Quarry, Swindon, Wiltshire. × 75 126

FIG. 13. *Stenestroemia cressida* sp. nov. Holotype, left valve, Mik (M) 2402001, Grinstead Cycle, *C. aculeata* Zone, Grinstead Clay, Wealden. Kingsclere No. 1 Borehole, Hampshire, at 996 ft. × 72 126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EXPLANATION OF PLATE XXII *Page*

FIG. 1. *Orthonotacythere rimosa* Martin. Male left valve, Mik (M) 3272001, Lower Purbeck. Quainton, Buckinghamshire. × 75 120

FIG. 2. *Orthonotacythere favulata* Martin. Male right valve, Mik (M) 3273001, Durlston Cycle, *C. g. fasciculata* Zone, Middle Purbeck. Netherfield Place No. 5 Borehole, Sussex, at 895 ft 4–5 in. × 74.

FIG. 3. *Orthonotacythere favulata* Martin. Female right valve, Mik (M) 3264001, Durlston Cycle, *C. g. fasciculata* Zone, Middle Purbeck. Netherfield Place No. 5 Borehole, Sussex, at 895 ft 0–1 in. × 75 119

FIG. 4. *Orthonotacythere cinerariq* sp. nov. Holotype, male left valve, Mik (M) 3268001, Cinder Beds Cycle, *C. g. fasciculata* Zone, Middle Purbeck. Poxwell Road Cutting, Dorset. × 72 119

FIG. 5. *Orthonotacythere nodosaria* sp. nov. Female left valve, Mik (M) 3266001. Horizon and locality as for fig. 4. × 70.

FIG. 6. *Orthonotacythere nodosaria* sp. nov. Holotype, male left valve, Mik (M) 3265001, Langton Cycle, *C. g. fasciculata* Zone, Middle Purbeck. Mountfield No. 3 Borehole, Sussex, at 297 ft. × 60 120

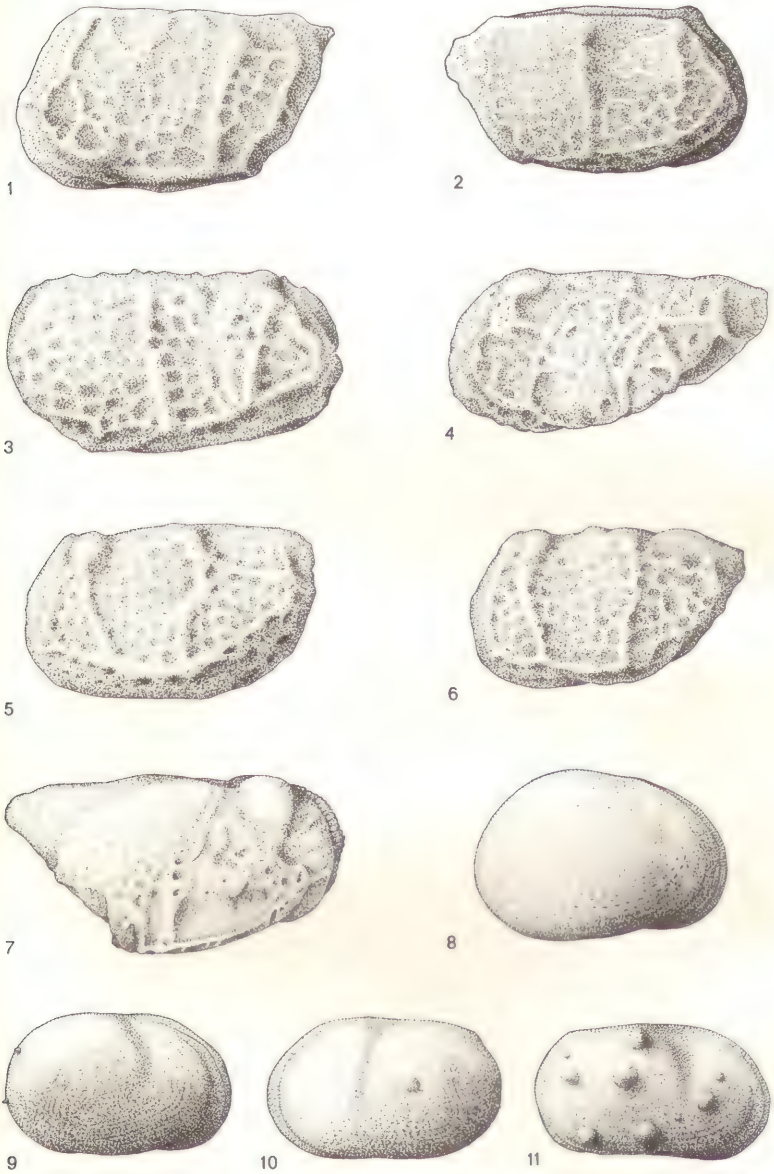
FIG. 7. *Stillina arkelli* sp. nov. Holotype, right valve, Mik (M) 3267001, Cinder Beds Cycle, *C. g. fasciculata* Zone, Middle Purbeck. Warlingham Borehole, Surrey, at 1992 ft 4–6 in. × 59 121

FIG. 8. *Theriosynoecum forbesii forbesii* (Jones). Female right valve, Mik (M) 3293001, Chert Bed, Middle Purbeck. Friar Waddon, Dorset. × 38.

FIG. 9. *Theriosynoecum forbesii forbesii* (Jones). Male right valve, Mik (M) 3294001, Middle Purbeck. Ridgeway, Dorset. × 39.

FIG. 10. *Theriosynoecum forbesii verrucosa* (Jones). ?Female left valve, Mik (M) 3295001, Middle Purbeck. Ridgeway, Dorset. × 39.

FIG. 11. *Theriosynoecum forbesii verrucosa* (Jones). Male right valve, Mik (M) 3296001, Middle Purbeck. Ridgeway, Dorset. × 38 128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EXPLANATION OF PLATE XXIII *Page*

FIG. 1. *Mantelliana* cf. *wealdensis* (Wolburg). Female left valve, Mik (M) 3219001, Goldspur Cycle, *C. g. granulosa* Zone, Middle Purbeck. Netherfield Place No. 5 Borehole, Sussex, at 913 ft 3–4 in. × 38.

FIG. 2. *Mantelliana* cf. *wealdensis* (Wolburg). Male right valve, Mik (M) 3220001, Goldspur Cycle, *C. g. granulosa* Zone, Middle Purbeck. Guestling No. 1 Borehole, Sussex, at 1019 ft 2–8 in. × 39 105

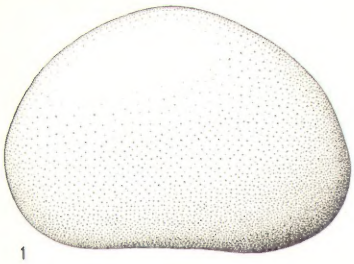
FIG. 3. *Mantelliana purbeckensis* (Forbes). Female left valve, Mik (M) 3310001, Wardour Cycle, Lower Purbeck. Goldspur Drift, Mountfield, Sussex, at 144 ft 2 in. × 40 105

FIG. 4. *Mantelliana cyrton* sp. nov. Holotype, left valve, Mik (M) 3217001, Wardour Cycle, Lower Purbeck. Mountfield No. 4 Borehole, Sussex, at 406 ft. × 39.

FIG. 5. *Mantelliana cyrton* sp. nov. Topotype, right valve, Mik (M) 3218001. Horizon and locality as for fig. 4. × 39 104

FIG. 6. *Scabriculocypris durlstonensis* sp. nov. Left valve, Mik (M) 3216001, Nothe Cycle, *C. g. fasciculata* Zone, Middle Purbeck. Chilcomb Down No. 1 Borehole, Hampshire, at 1819 ft. × 38.

FIGS. 7–8. *Scabriculocypris durlstonensis* sp. nov. Holotype, right and left valves, Mik (M) 3215001, Croydon Cycle, *C. g. fasciculata* Zone, Middle Purbeck. Durlston Bay, Dorset. × 38 100



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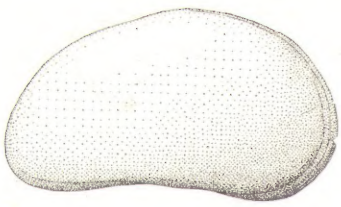

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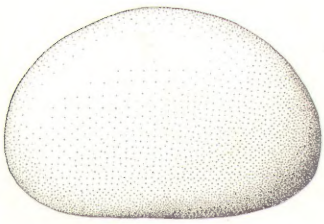

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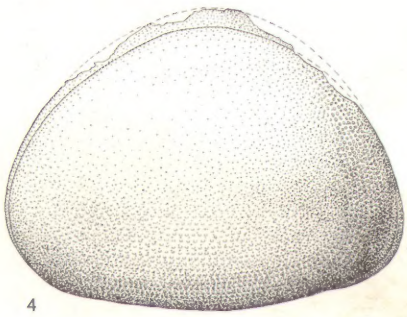

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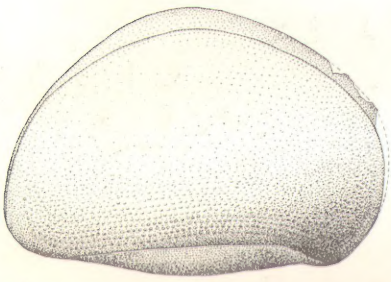

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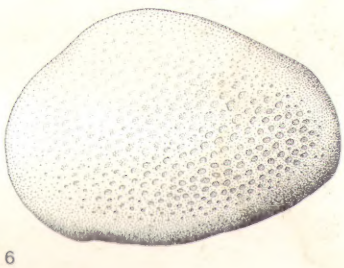

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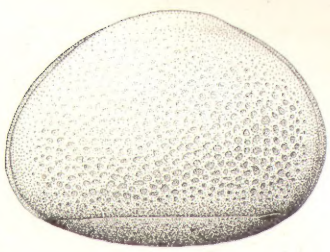

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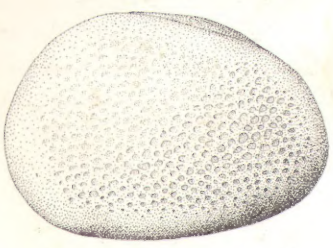

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